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A REVIEW OF GENUS *CYRTODACTYLUS* (REPTILIA: SAURIA: GEKKONIDAE) IN FAUNA OF LAOS WITH DESCRIPTION OF FOUR NEW SPECIES

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ABSTRACT

We describe four new species of the genus *Cyrtodactylus* based on the results of phylogenetic analysis of 673 bp of the COI mtDNA gene and morphological description of voucher specimens from Khammouane and Vientiane provinces, Laos. The three of the new species, namely *Cyrtodactylus khammouanensis* sp. nov., *Cyrtodactylus darevskii* sp. nov. and *Cyrtodactylus multiporus* sp. nov., are described from a small area in monsoon tropical forests on limestone in the environs of Nahome Village, Boulapha District, Khammouane Province, Central Annamites. *Cyrtodactylus darevskii* sp. nov. differs from all other Laotian *Cyrtodactylus* by a combination of the following morphological characters: (1) maximum SVL up to 100 mm; (2) dorsal pattern formed by the narrow dark nuchal band and 4–5 dark transverse breaking bands with light yellowish posterior edges between limbs; (4) 38–46 ventral scales; (5) continuous series of 38–44 precloacal and femoral pores in males and 24–34 precloacal and femoral pores in females; (6) preclocal groove lacking; (7) 4–5 postcloacal spurs present in both sexes; (8) one median row of subcaudal scales. *Cyrtodactylus khammouanensis* sp. nov. appears to be closely related to the recently described *C. jaegeri* Luu *et. al*., 2014 and can be distinguished from this species and the remaining Laotian congeners by a combination of the following morphological features: (1) medium size, with a maximum SVL up to 73 mm; (2) males with continuous series of 40–44 precloacal and femoral pores; (3) preclocal groove lacking; (4) 32–38 longitudinal rows of ventral scales at midbody; (5) weakly keeled tubercles present on the dorsum and lacking on the head; (6) 5–6 enlarged postcloacal spurs in both sexes; (8) one median row of subcaudal scales; (7) dorsal pattern consisting of wide dark nuchal band and 4–5 dark wide transverse bands. *Cyrtodactylus multiporus* sp. nov. is distinguished by a combination of the following morphological attributes: (1) maximum SVL of up to 98 mm; (2) dorsal patterns consisting of dark irregular separate spots between limbs and on the dorsal surface of the head; (3) nuchal band absent; (4) 30–38 ventrals; (5) continuous series of 58–60 precloacal and femoral pores in males; (6) preclocal groove lacking; (7) 5–6 postcloacal spurs present in both sexes; (8) one median row of subcaudal scales. *Cyrtodactylus spelaeus* sp. nov. is described from a cave in north of Vientiane Province of Laos and differs from other congeners by a combination of the following characters: (1) maximum SVL of 98 mm; (2) dorsal pattern formed by oblong dark irregular butterfly-shaped blotches with light contrast margins; (3) nuchal band with light edging consists of two separate parts, which contact in occipital region; (4) 37–39 ventral scales; (5) 7–8 precloacal pores in males; (5) preclocal groove lacking; (6) 2–3 postcloacal spurs present in both sexes; (7) ten rows of enlarged dorsal tubercles. Our study increase the number of *Cyrtodactylus* species known for Laos to fifteen. COI DNA-barcoding is successfully applied to reveal cryptic diversity within the genus *Cyrtodactylus*.

Key words: Central Annamites, COI barcoding, *Cyrtodactylus darevskii* sp. nov., *Cyrtodactylus khammouanensis* sp. nov., *Cyrtodactylus multiporus* sp. nov., *Cyrtodactylus spelaeus* sp. nov., Laos, sympatry, taxonomy

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ОБЗОР РОДА *CYRTODACTYLUS* (REPTILIA: SAURIA: GEKKONIDAE) ФАУНЫ ЛАОСА С ОПИСАНИЕМ ЧЕТЫРЕХ НОВЫХ ВИДОВ

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РЕЗЮМЕ

В статье по результатам филогенетического анализа фрагмента гена первой субъединицы цитохром *с*-оксидахы мтДНК (COI) длиной 673 п.о. и морфологического исследования ваучерных экземпляров приводится описание четырех новых видов кривопалых гекконов рода *Cyrtodactylus* из провинций Кхаммуан и Вьентьян, Лаос. Три из описанных новых для науки видов, а именно *Cyrtodactylus khammouanensis* sp. nov., *Cyrtodactylus darevskii* sp. nov. и *Cyrtodactylus multiporus* sp. nov., обнаружены на небольшой территории, покрытой мусонными тропическими лесами и карстовыми массивами, в окрестностях деревни Нахом, район Буалапха, провинция Кхаммуан, центральная часть Аннамского хребта. *Cyrtodactylus darevskii* sp. nov. отличается от всех прочих кривопалых гекконов фауны следующей комбинацией морфологических признаков: (1) максимальная длина тела SVL до 100 мм; (2) окраска дорзальной стороны тела сорфмирована узкой темной затылочной (нухальной) полосой и 4–5 темными поперечными прерывистыми полосами с тонкой желтой окантовкой между передними и задними конечностями; (4) 38–46 рядов брюшных чешуй; (5) непрерывающиеся ряды из 38–44 предклоакальных и бедренных пор у самцов и 24–34 предклоакальных и бедренных пор у самок; (6) предклоакальная бороздка отсутствует; (7) 4–5 постклоакальных шипов развиты обоих полов; (8) выражен один медиальный ряд подхвостовых чешуй. *Cyrtodactylus khammouanensis* sp. nov. по-видимому близок к описанному недавно виду *C. jaegeri* Luu *et. al*., 2014, однако отличается от него вида, как и других лаосских *Cyrtodactylus*, следующими признаками внешней морфологии: (1) средний размер, с максимальной длиной тела SVL до 73 мм; (2) самцы с непрерывным рядом из 40–44 предклоакальных и бедренных пор; (3) предклоакальная бороздка отсутствует; (4) 32–38 продольных рядов брюшных чешуй в средней части туловища; (5) слабо-килеватые бугорки расположены на дорзальной поверхности тела, но отсутствуют на голове; (6) 5–6 увеличенных постклоакальных шипов как у самцов, так и у самок; (8) выражен один медиальный ряд подхвостовых чешуй; (7) рисунок спинной поверхности тела образован широкой затылочной полосой и 4–5 темными поперечными полосами. *Cyrtodactylus multiporus* sp. nov. отличается от других видов рода следующим сочетанием морфологических характеристик: (1) максимальная длина туловища SVL до 98 mm; (2) рисунок дорзальной поверхности тела представлена отдальными темными пятнами неправильной формы, разбросанными по спине и заходящими на дорзальную поверхность головы; (3) затылочная полоса отсутствует; (4) 30–38 брюшных чешуй; (5) у самцов 58–60 преклоакальных и бедренных пор расположенных в непрерывном ряду; (6) предклоакальная бороздка отсутствует; (7) 5–6 увеличенных постклоакальных шипов как у самцов, так и у самок; (8) выражен один медиальный ряд подхвостовых чешуй. *Cyrtodactylus spelaeus* sp. nov. описан из пещеры в северной части провинции Вьентьян, Лаос, и отличается от других кривопалых гекконов региона следующими морфологическими признаками: (1) максимальная длина тела SVL до 98 мм; (2) окраска спинной поверхности тела образована продолговатыми темными пятнами со светлой окантовкой по краю; (3) затылочная полоса имеет тонкую светлую окантовку и состоит из двух частей, конатктирующих в затылочной части черепа; (4) 37–39 брюшных чешуй; (5) 7–8 предклоакальных

пор у самцов; (5) предклоакальная бороздка отсутсвует; (6) 2–3 увеличенных постклоакальных шипа как у самцов, так и у самок; (7) десять рядов увеличенных спинных бугорков. Наше исследование увеличивает число видов рода *Cyrtodactylus*, известных для Лаоса, до пятнадцати. Мы также успешно применили методы ДНК индентификации (COI ДНК-баркодинг) к оценке криптического разнообразия рода *Cyrtodactylus*.

Ключевые слова: центральный Аннам, COI barcoding, *Cyrtodactylus darevskii* sp. nov., *Cyrtodactylus khammouanensis* sp. nov., *Cyrtodactylus multiporus* sp. nov., *Cyrtodactylus spelaeus* sp. nov., Лаос, симпатрия, систематика

INTRODUCTION

The genus *Cyrtodactylus* is one of the largest genera of the gekkonid lizards and to date includes about 196 recognized species, distributed in the mainland Southern and Southeast Asia, Himalayas, Indonesia, northern Australia and Oceania (Uetz et al. 2014). *Cyrtodactylus* thus forms the most diverse genus of Gekkonidae to date, with Indochina representing one of the centers of undiscovered species diversity of this genus. Over the last decade, the diversity of the genus has increased at several times as a result of numerous descriptions of new species from poorly studied areas of Indochina and Indonesia. In 1997 only 18 species of the genus *Cyrtodactylus* were recorded from the huge territory of Southeast Asia (Manthey and Grossmann 1997). The number of described species has increased rapidly since 2007; in Vietnam, for example, the number of recognized species has increased from just 5 species known in 2006 to 33 species recognized in 2014 (Nguyen et al. 2014). There has been an enormous increase in the number of new species of the genus from Southeast Asia and Oceania, resulting in a total of at least 90 species recognized by 2008 (Ngo and Bauer 2008). At least 44 species of the genus *Cyrtodactylus* were reported from Indochina – Thai region for 2011 (Uetz et al. 2011).

The numerous new records and discoveries from mainland Southeast Asia have been documented mainly for Malaysia, Vietnam and Thailand. From Laos only ten species of *Cyrtodactylus* have been recorded to date: *C. buchardi* David, Teynié et Ohler, 2004, *C. interdigitalis* Ulber, 1993, *Cyrtodactylus jaegeri* Luu, Calame, Bonkowski, Nguyen et Ziegler, 2014; *C. jarujini* Ulber, 1993, *C. lomyenensis* Ngo et Pauwels, 2010, *Cyrtodactylus pageli* Schneider, Nguyen, Schmitz, Kingsada, Auer et Ziegler, 2011; *Cyrtodactylus roesleri* Ziegler, Nazarov, Orlov, Nguyen, Vu, Dang, Dinh et Schmitz, 2010; *C. teyniei* David, Nguyen, Schneider et Ziegler, 2011; *Cyrtodactylus vilaphongi* Schneider, Nguyen, Duc Le, Nophaseud, Bonkowski et Ziegler, 2014; *C. wayakonei* Nguyen, Kingsada, Rösler, Auer et Ziegler, 2010; suggesting that our knowledge of Laotian herpetofauna is still far from being complete (Stuart 1999; David et al. 2004; Teynié et al. 2004; Teynié and David 2010; Ngo and Pauwels 2010; Nguyen et al. 2010; David et al. 2011; Luu et al. 2013). Our field research in Laos at 2009 and 2011 led to discovery of four new populations of *Cyrtodactylus* of unclear taxonomic status.

Methods of DNA identification, or DNA barcoding, serve as important tools for biodiversity assessment since they can be especially useful for identification of cryptic species (Hebert et al. 2003, 2004; Smith et al. 2008). Herein we use DNA barcoding with COI to reexamine the taxonomic status of known species of Laotian bent-toed geckos as well as to explore the status of newly collected specimens in the region. We use this gene, in part, because of its application in documenting genetic diversity through the Cold Code project (Murphy et al. 2013), and also referring to its successful application to biodiversity assessment of the genus *Cyrtodactylus* (Nazarov et al. 2012; Nguyen et al. 2013, 2014; Schneider et al. 2014a, 2014b). Our investigation results in the description of four new species of *Cyrtodactylus* based on both genetics and morphology.

MATERIAL AND METHODS

Sample collection. Field work was conducted in the Laotian provinces of Vientiane, Luang Prabang and Khammouane in 2009–2013. Specimens were anaesthetized, ethanol-fixed and subsequently deposited in the collections of the Zoological Institute, St. Petersburg (ZIN), Russian Academy of Sciences, Russia; Zoological Museum, Lomonosov Moscow State University (ZMMU), Moscow, Russia. The geographic position of the surveyed localities and

the distribution of the known *Cyrtodactylus* species in the Central Annamite Mountains (Truong Son) and adjacent regions of southern Indochina (central and northern Vietnam, Laos, north-eastern part of Thailand) are shown in Fig. 1. For localities of *Cyrtodactylus* distribution in Laos and adjacent areas see Fig. 1.

Morphology. For the morphological descriptions and comparisons, the following measurements (taken with caliper rule to the nearest 0.1 mm) and scalation characters were used (after Darevsky, Szczerbak 1997; Bauer 2002, 2003; Bauer et al. 2002, 2003; Ziegler et al. 2002; David et al. 2004; Nguyen et al. 2006; Hoang et al. 2007; Nazarov et al. 2008): Snout-vent length (SVL, from tip of snout to vent); tail length (TailL, from vent to tip of tail); head length (HeadL, distance between retroarticular process of jaw and snout-tip); head width (HeadW, maximum width of head); head height (HeadH, maximum height of head, from occiput to underside of jaws); orbital diameter (OrbD, greatest diameter of orbit); snout to eye distance (SnEye, distance between anterior most point of eye and tip of snout); ear length (EarL, longest dimension of ear); trunk length (TrunkL, distance from axilla to groin measured from posterior edge of forelimb insertion to anterior edge of hind limb insertion); shoulder length (LS); forearm length (ForeaL, from base of palm to elbow); femur length (FemurL); crus length (Crus L, from base of heel to knee); length of finger IV (LF4); length of toe IV (LT4); eye to ear distance (EyeEar, distance from anterior edge of ear opening to posterior corner of eye); scales across the belly in the middle of the body (V); number of scales along the midbody from mental shield to anterior edge of cloaca (SLB), supralabials (SL); infralabials (IL); precloacal pores (PP); femoral pores (FP); enlarged femoral scales (EFS); number of basal and distal subdigital lamellae under fourth finger (SDL4A); number of basal and distal subdigital lamellae under fourth toe (SDL4P), number of longitudinal rows of enlarged tubercles in the middle of dorsum between ventrolateral folds (TubL); number of transversal rows of enlarged tubercles between occipital region and middle of sacrum along the middle of dorsum (TubW); number of scales along middle of head, between occiput sinus and supranasals (SLH); scales across head, between top of ear openings (SAH); rostral width, between supralabials (RW); rostral height, between anterior and posterior margins of rostral (RH).

We also obtained comparative morphological data on *Cyrtodactylus* species found in Laos and surrounding parts of Vietnam and Thailand: *C. bichnganae*, *C. buchardi*, *C. chauquangensis*, *C. cryptus*, *C. cucphuongensis*, *C. huongsonensis*, *C. interdigitalis*, *C. jaegeri*, *C. jarujini*, *C. kunyai*, *C. lomyenensis*, *C. martini*, *C. pageli*, *C. phongnhakebangensis*, *C. pseudoquadrivirgatus*, *C. puhuensis*, *C. roesleri*, *C. taynguyenensis*, *C. teyniei*, *C. vilaphongi*, *C. wayakonei* from literature (Ngo and Grismer 2010; David et al. 2004; Hoang et al. 2007; Heidrich et al. 2007; Ngo and Chan 2011; Luu et al. 2011; Ulber 1993; Luu et al. 2014; Pauwels et al. 2014; Ngo and Pauwels 2010, Ngo 2011; Schneider et al. 2011; Ziegler et al. 2003; Rösler et al. 2008; Nguyen et al. 2014; Ziegler et al. 2010; Nguyen et al. 2013; David et al. 2011; Schneider et al. 2014b; Nguyen et al. 2010). Due to the high undiagnosed diversity within the genus, where available, we relied on examination of topotypic material and/or original species descriptions.

Molecular comparisons. List of the samples and sequences with GenBank Accession Numbers is given in the Table 1. In the molecular analyses we included 64 samples *Cyrtodactylus* species from Laos and central Vietnam. For the Laotian populations we tried to include several specimens per population where it was possible. We also included all sequences on *Cyrtodactylus* species from Laos, central and northern Vietnam and southern China available in the GenBank (published in recent papers: Nguyen et al. 2013, 2014; Schneider et al. 2014b). COI gene fragment sequences of a *Gekko gecko* from southern China (Wang et al. 2012) was used as outgroup within the phylogenetic analyses.

DNA extraction, PCR and sequencing. Total genomic DNA was extracted from ethanol-preserved muscle or liver tissues using a glass-fiber automatic DNA isolation protocol following Ivanova et al. (2006) or using standard phenol–chloroform extraction procedures (Hillis et al. 1996) followed with isopropanol precipitation. We amplified 673 bp of Cytochrome oxidase I (COI), a mitochondrial marker proved to be useful for species identification in reptiles and widely used as a barcoding marker for vertebrates (Hebert et al. 2003, 2004; Smith et al. 2008; Solovyeva et al. 2011, 2012; Murphy et al. 2013; Hartmann et al. 2013; Nazarov and Poyarkov 2013), and successfully applied to the studies of cryptic diversity in the genus *Cyrtodactylus* (Nazarov et al. 2012; Nguyen et al. 2013, 2014; Schneider

Table 1. Specimens and localities of *Cyrtodactylus* used in our molecular analysis.

Specimen ID	GenBank A.N.	Species	Country	Province	Locality	Reference
PNKB4	KF169972	*C. cryptus*	Vietnam	Quang Binh	U Bo, Phong Nha–Ke Bang NP	Nguyen et al. 2013
PNKB3	KF169971	*C. cryptus*	Vietnam	Quang Binh	U Bo, Phong Nha–Ke Bang NP	Nguyen et al. 2013
PNKB2	KF169970	*C. cryptus*	Vietnam	Quang Binh	U Bo, Phong Nha–Ke Bang NP	Nguyen et al. 2013
PNKB1	KF169969	*C. cryptus*	Vietnam	Quang Binh	U Bo, Phong Nha–Ke Bang NP	Nguyen et al. 2013
ZMMU RAN 1999	HQ543944	*C. darevskii* sp. nov.	Laos	Khammouane	Na Home, Boulapha	this paper
ZIN FN 185	HQ967222	*C. darevskii* sp. nov.	Laos	Khammouane	Na Home, Boulapha	this paper
ZIN FN 188	HQ967225	*C. darevskii* sp. nov.	Laos	Khammouane	Na Home, Boulapha	this paper
ZIN FN 186	HQ967224	*C. darevskii* sp. nov.	Laos	Khammouane	Na Home, Boulapha	this paper
ZIN FN 187	HQ967223	*C. darevskii* sp. nov.	Laos	Khammouane	Na Home, Boulapha	this paper
ZIN FN 256	HQ967221	*C. darevskii* sp. nov.	Laos	Khammouane	Na Home, Boulapha	this paper
ZINFN189	KF929541	*C. darevskii* sp. nov.	Laos	Khammouane	Na Home, Boulapha	Nguyen et al. 2014
ZINFN187	KF929540	*C. darevskii* sp. nov.	Laos	Khammouane	Na Home, Boulapha	Nguyen et al. 2014
ZINFN186	KF929539	*C. darevskii* sp. nov.	Laos	Khammouane	Na Home, Boulapha	Nguyen et al. 2014
ZINFN185	KF929538	*C. darevskii* sp. nov.	Laos	Khammouane	Na Home, Boulapha	Nguyen et al. 2014
IEBR A.2013.89	KJ817429	*C.* cf. *darevskii* sp. nov.	Laos	Khammouane	–	Schneider et al. 2014
ITBCZ-10023	KP199951	*C. irregularis*	Vietnam	Lam Dong	–	this paper
ITBCZ-10016	KP199952	*C. irregularis*	Vietnam	Lam Dong	–	this paper
ITBCZ-10025	KP199953	*C. irregularis*	Vietnam	Lam Dong	–	this paper
ZMMU R-13980-2	KP199946	*C. spelaeus* sp. nov.	Laos	Vientiane	Khuang Lang N.P., Kasi	this paper
ZMMU R-13980-3	KP199947	*C. spelaeus* sp. nov.	Laos	Vientiane	Khuang Lang N.P., Kasi	this paper
ZMMU R-13980-1	KP199948	*C. spelaeus* sp. nov.	Laos	Vientiane	Khuang Lang N.P., Kasi	this paper
ZIN FN 192	HM888468	*C. khammouanensis* sp. nov.	Laos	Khammouane	Na Home, Boulapha	this paper
ZIN FN 257	HM888469	*C. khammouanensis* sp. nov.	Laos	Khammouane	Na Home, Boulapha	this paper
ZIN FN 191	HM888467	*C. khammouanensis* sp. nov.	Laos	Khammouane	Na Home, Boulapha	this paper
ZIN FN257	KF929544	*C. khammouanensis* sp. nov.	Laos	Khammouane	Na Home, Boulapha	Nguyen et al. 2014
ZIN FN192	KF929543	*C. khammouanensis* sp. nov.	Laos	Khammouane	Na Home, Boulapha	Nguyen et al. 2014
ZIN FN191	KF929542	*C. khammouanensis* sp. nov.	Laos	Khammouane	Na Home, Boulapha	Nguyen et al. 2014
IEBR KM2012.52	KP199942	*C. lomyenensis*	Laos	Khammouane	Lomyen, Gnommalath	this paper
IEBR KM2012.53	KP199943	*C. lomyenensis*	Laos	Khammouane	Lomyen, Gnommalath	this paper
IEBR KM2012.54	KJ817436	*C. lomyenensis*	Laos	Khammouane	–	Schneider et al. 2014
KIZ201103	KF929537	*C.* cf. *martini*	China	Yunnan	Xishuangbanna	Nguyen et al. 2014

Table 1.(*Continued*).

Specimen ID	GenBank A.N.	Species	Country	Province	Locality	Reference
ZMMU RAN 1994-2	HQ967191	*C. multiporus* sp. nov.	Laos	Khammouane	Na Home, Boulapha	this paper
ZMMU RAN 1996-2	HQ967193	*C. multiporus* sp. nov.	Laos	Khammouane	Na Home, Boulapha	this paper
ZIN FN 3	HM888472	*C. multiporus* sp. nov.	Laos	Khammouane	Na Home, Boulapha	this paper
ZIN FN 2	HM888471	*C. multiporus* sp. nov.	Laos	Khammouane	Na Home, Boulapha	this paper
ZIN FN 1	HM888470	*C. multiporus* sp. nov.	Laos	Khammouane	Na Home, Boulapha	this paper
ZMMU RAN 1998	HQ543943	*C. multiporus* sp. nov.	Laos	Khammouane	Na Home, Boulapha	this paper
ZMMU RAN 1995-2	HQ967192	*C. multiporus* sp. nov.	Laos	Khammouane	Na Home, Boulapha	this paper
ZFMK91827	KJ817431	*C. pageli*	Laos	Vientiane	–	Schneider et al. 2014
PNKN2011119	KF929528	*C. phongnhakebangensis*	Vietnam	Quang Binh	Phong Nha–Ke Bang NP	Nguyen et al. 2014
PNKN201132	KF929527	*C. phongnhakebangensis*	Vietnam	Quang Binh	Phong Nha–Ke Bang NP	Nguyen et al. 2014
PNKN201130	KF929526	*C. phongnhakebangensis*	Vietnam	Quang Binh	Phong Nha–Ke Bang NP	Nguyen et al. 2014
ITBCZ3002	KF169964	*C. pseudoquadrivirgatus*	Vietnam	Thua Thien–Hue	A Luoi	Nguyen et al. 2013
ITBCZ3001	KF169963	*C. pseudoquadrivirgatus*	Vietnam	Thua Thien–Hue	A Luoi	Nguyen et al. 2013
ZMMU R-13095-2	KP199949	*C.* cf. *pseudoquadrivirgatus*	Vietnam	–	–	this paper
KIZ11665	KF929529	*C. puhuensis*	Vietnam	Thanh Hoa	Pu Hu	Nguyen et al. 2014
IEBR A.2013.109	KJ817428	*C.* cf. *puhuensis*	Laos	Houphan	–	Schneider et al. 2014
PNKB201134	KF929532	*C. roesleri*	Vietnam	Quang Binh	Phong Nha–Ke Bang NP	Nguyen et al. 2014
PNKB20113	KF929531	*C. roesleri*	Vietnam	Quang Binh	Phong Nha–Ke Bang NP	Nguyen et al. 2014
PNKB20111	KF929530	*C. roesleri*	Vietnam	Quang Binh	Phong Nha–Ke Bang NP	Nguyen et al. 2014
IEBR A.2013.112	KJ817437	*C.* cf. *roesleri*	Laos	Khammouane	–	Schneider et al. 2014
ROM32120	KF169979	*C. taynguyenensis*	Vietnam	Gia Lai	Krong Pa, K Bang	Nguyen et al. 2013
ROM32119	KF169978	*C. taynguyenensis*	Vietnam	Gia Lai	Krong Pa, K Bang	Nguyen et al. 2013
IEBR KM2012.14	KP199944	*C. teyniei*	Laos	Khammouane	–	this paper
IEBR KM2012.77	KP199945	*C. teyniei*	Laos	Khammouane	–	this paper
IEBR KM2012.77	KJ817430	*C. teyniei*	Laos	Khammouane	–	Schneider et al. 2014
NUOL R-2013.5	KJ817434	*C. vilaphongi*	Laos	Luang Prabang	–	Schneider et al. 2014
IEBR A.2013.103	KJ817435	*C. vilaphongi*	Laos	Luang Prabang	–	Schneider et al. 2014
ZMMU R-13981-1	KP199950	*C. wayakonei*	Laos	Luang Nam Tha	–	this paper
ZFMK91016	KJ817438	*C. wayakonei*	Laos	Luang Nam Tha	–	Schneider et al. 2014
ITBCZ2532	KF169962	*Cyrtodactylus* sp. 1	Vietnam	Da Nang	Ba Na	Nguyen et al. 2013
IEBR A.2013.110	KJ817432	*Cyrtodactylus* sp. 2	Laos	Luang Prabang	–	Schneider et al. 2014
IEBR A.2013.111	KJ817433	*Cyrtodactylus* sp. 2	Laos	Luang Prabang	–	Schneider et al. 2014
–	JF920657	*Gekko gecko*	China	–	–	Wang et al. 2012

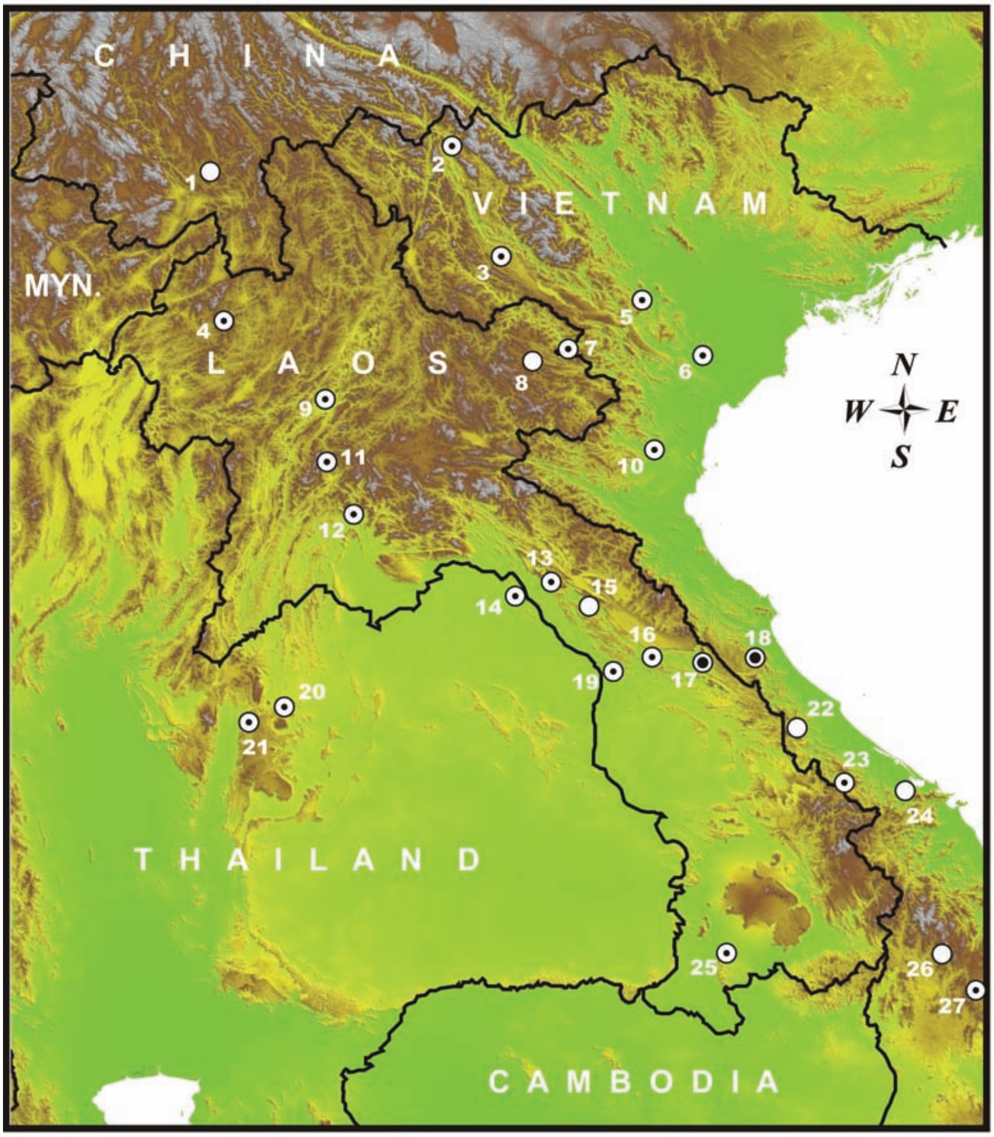


Fig. 1. General distribution of the genus *Cyrtodactylus* in Central Annamites and surrounding areas; dot in the center of icon indicates the type locality; large dot indicates type localities for several species of *Cyrtodactylus*: 1 – *Cyrtodactylus* cf. *martini* – Xishuangbanna, Yunnan Province, China; 2 – *C. martini* – Lai Chau, Lai Chau Province, Vietnam; 3 – *C. bichnganae* – Son La, Son La Province, Vietnam; 4 – *C. wayakonei* – Kao Rao Cave, Ban Nam Eng, Vieng Phoukha, Luang Nam Tha Province, Laos; 5 – *C. huongsonensis* – Huong Son, My Duc, Hanoi, Vietnam; 6 – *C. cucphuongensis* – Cuc Phuong N.P., Nho Quan, Ninh Binh Province, Vietnam; 7 – *C. puhuensis* – Pu Hu, Thanh Hoa Province, Vietnam; 8 – *C.* cf. *puhuensis* – Houphan Province, Laos; 9 – *C. vilaphongi* – Ban Xieng Muak, Luang Prabang, Luang Prabang Province, Laos; 10 – *C. chauquangensis* – Chau Quang, Quy Hop, Nghe An Province, Vietnam; 11 – *C.* cf. *interdigitalis* and *C. spelaeus* sp. nov. – Khuang Lang N.P., Kasi, Vientiane Province, Laos; 12 – *C. pageli* – Phoukham Cave, Ban Na Thong, Vang Vieng, Vientiane Province, Laos; 13 – *C. teyniei* – Ban Na Hin, Nam Kading NBCA, Borikhamxay Province, Laos; 14 – *C. jarujini* – Phu Wua W.S., Nong Dern, Bung Kan, Nong Khai Province, Thailand; 15 – *C.* cf. *teyniei* –Nahin, Khammouane Province, Laos; 16 – *C. lomyensis* – Lomyen Cave, Gnommalath, Khammouane Province, Laos; 17 – *C. darevskii* sp. nov., *C. khammouanensis* sp. nov. and *C. multiporus* sp. nov.– Na Home, Boulapha, Khammouane Province, Laos; 18 – *C. phonghnakebangensis*, *C. cryptus* and *C. roesleri* – Phong Nha – Ke Bang N.P., Minh Hoa, Quang Binh Province, Vietnam; 19 – *C. jaegeri* – Thakhek, Khammouane Province, Laos; 20 – *C. kunyai* – Suan Hin Pha Ngam, Nong Hin District, Loei Province, Thailand; 21 – *C. interdigitalis* – Tham Yai Nam Nao, Nam Nao N.P., Petchabun Province, Thailand; 22 – *C. pseudoquadrivirgatus* – Huong Hoa, Quang Tri Province, Vietnam; 23 – *C. pseudoquadrivirgatus* – A Luoi, Thua Thien – Hue Province, Vietnam; 24 – *Cyrtodactylus* sp. 1 – Ba Na, Da Nang, Vietnam; 25 – *C. buchardi* – Kiatngong, Xepian NBCA, Champasak Province, Laos; 26 – *C.* cf. *taynguyenensis* – Kon Plong, Kon Tum Province, Vietnam; 27 – *C. taynguyenensis* – Krong Pa, Gia Lai Province, Vietnam.

et al. 2014a, 2014b). Primers used both for PCR and sequencing were the VF1-d (5'-TTCTCAACCAACCACAARGAYATYGG-3') and the VR1-d (5'-TAGACTTCTGGGTGGCCRAARAAYCA-3') (following Ivanova et al. 2006). The obtained fragments were sequenced in both directions for each sample, and a consensus sequence was generated. PCRs were performed in 25 µl reactions using ca. 50 ng genomic DNA, 10 pmol of each primer, 15 nmol of each dNTP, 50 nmol additional MgCl 2, Taq PCR buffer (10 mM Tris-HCl, pH 8.3, 50 mM KCl, 1.1 mM MgCl 2 and 0.01% gelatine) and 1 U of Taq DNA polymerase. The PCR conditions were: an initial denaturation step at 95 °C for 3 min; 5 cycles at 95 °C for 30 s, annealing at 45 °C for 1 m, extension at 72 °C for 2 min followed with 35 cycles at 95 °C for 30 s, annealing at 51 for 1 m, extension at 72 °C for 2 min and final extension of 5 min at 72 °C. PCR products were loaded onto 1% agarose gels, stained with GelStar gel stain (Cambrex), and visualized in a Dark reader transilluminator (Clare Chemical). If results were satisfying, products were purified using 2 µl, from a 1:4 dilution of ExoSapIt (Amersham), per 5 µl of PCR product prior to cycle sequencing. A 10 µl sequencing reaction included 2 µL of template, 2.5 µl of sequencing buffer, 0.8 µl of 10 pmol primer, 0.4 µl of BigDye Terminator version 3.1 Sequencing Standard (Applied Biosystems) and 4.2 µl of water. The sequence reaction was 35 cycles of 10 sec at 96 °C, 10 s at 50 °C and 4 min at 60 °C. Cycle sequencing products were purified by ethanol precipitation. Sequence data collection and visualization were performed on an ABI 3730xl automated sequencer (Applied Biosystems). Obtained sequences are accessible at BOLD systems website (http://www.boldsystems.org) and are deposited in GenBank under accession numbers HM888467–HM888472; HQ543943–HQ543944; HQ967191–HQ967193; HQ967221–HQ967225; KP199942–KP199953 (see Table 1).

Phylogenetic analysis. Final alignment used for phylogenetic analysis contained 673 bp of COI gene for 64 specimens belonging to approximately 19 *Cyrtodactylus* species and 1 outgroup sequence of *Gekko gecko* (summarized in Tabl. 1). Sequences were initially aligned automatically by ClustalX 1.81 (Thompson et al. 1997) and then optimized by eye using BioEdit Sequence Alignment Editor 5.0.9 (Hall 1999). Sequences were also submitted to a BLAST search in GenBank to confirm that the intended sequences had been amplified. Mean uncorrected genetic distances (*p*-distances) between sequences were determined with MEGA 6.0 (Tamura et al. 2013). MODELTEST v.3.06 (Posada and Crandall 1998) was used to estimate the optimal evolutionary models to be used for the data set analysis. The best-fitting model as suggested by the Akaike Information Criterion (AIC) was the (GTR + I + G) model of DNA evolution. Phylogenetic analyses were conducted in PAUP version 4.0b4a (Swofford 1998) and MEGA6.06 (Tamura et al. 2013) software.

Phylogenetic analyses were conducted in Treefinder (Jobb et al. 2004) and MrBayes 3.1.2 (Huelsenbeck, Ronquist 2001; Ronquist, Huelsenbeck 2003) software. The Maximum Likelihood (ML) analyses were conducted using Treefinder (Jobb et al. 2004). Transitions and transversions were equally weighted, and gaps were treated as missing data. Confidence in tree topology was tested by non-parametric bootstrap analysis (Felsenstein 1985) with 1000 replicates, and by posterior probability (PP) for Bayesian inference (BI) in MrBayes 3.1.2 (Huelsenbeck, Ronquist 2001). We *a priori* regarded tree nodes with bootstrap values 70% or greater and posterior probabilities values over 0.95 as sufficiently resolved, those between 75% and 50% (0.95 and 0.90 for BI) were regarded as tendencies, those below 50% (0.90 for BI) were considered to be non-resolved (Huelsenbeck and Hillis 1993).

RESULTS

Molecular differentiation of Laotian *Cyrtodactylus*

Sequence statistics. The final alignment of the studied COI mtDNA fragment consisted of 673 sites in which 407 sites were conserved, 266 variable and 258 of them were potentially parsimony-informative; the transition–transversion bias was estimated as 2.49 (all data given for ingroups only). Substitution rates were estimated under the Kimura's 2-parameter model (+G+I). Nucleotide frequencies were A = 23.0%, T = 26.0%, C = 31.0%, and G = 20.0%.

Sequence divergence. The uncorrected *p*-distances among and within COI gene fragment sequences of the studied *Cyrtodactylus* taxa and the outgroup (*Gekko gecko*) are shown in the Table 2.

Phylogenetic relationships. As shown by a number of previous studies, phylogenetic analysis of the COI fragment is a powerful tool for molecular diagnostics of biodiversity within the taxonomi-

cally complicated genus *Cyrtodactylus* (Nazarov et al. 2012; Nguyen et al. 2013, 2014; Schneider et al. 2011, 2014a, 2014b). Though resolving phylogeny of the genus *Cyrtodactylus* would require more genes and taxa to be studied (see Wood et al. 2012), the 673-bp fragment of the COI analyzed herein demonstrates phylogenetic signal which is strong enough to provide significant support values for some nodes in the resulted tree. These phylogenetic patterns are briefly discussed below.

The results of the phylogenetic analysis of the COI gene are shown in Fig. 2. Phylogenetic relationships between the accessed taxa of *Cyrtodactylus* are poorly resolved with major basal nodes in the tree having low (BS < 75%) or insignificant levels (BS < 50%; BPP < 0.95) of support, whereas monophyly of species-level groups and species complexes is significantly supported (BS > 90%; BPP ≥ 0.95).

Both ML and BI analyses resulted in essentially similar topologies. They differed only in associations at poorly supported nodes. The ML tree (Fig. 2) infers the following set of phylogenetic relationships among studied *Cyrtodactylus* species, which in general corresponds well to the preliminary tree for Laotian species reported by Schneider et al. (2014b):

(1) The phylogenetic analyses revealed 21 lineages mtDNA haplotypes in *Cyrtodactylus* of Laos and adjacent parts of Vietnam and China included in the present work (see groups 1–21 in Fig. 2). These groups roughly correspond to species-level of differentiation and have high levels of BS and PP statistical support of their monophyly.

(2) Altogether, the revealed 21 matrilineal lineages of *Cyrtodactylus* are grouped into three major clades, corresponding to the level of species groups in the genus *Cyrtodactylus* (see groups A–C in Fig. 2). The level of statistical support of their monophyly varies from high (for groups A and C) to moderate (for group B).

(3) Group A, which we here tentatively indicate as *C. phongnhakebangensis* species group, includes lineages 1–9 which represent species associated with limestone habitats in central Vietnam (*C. phongnhakebangensis* (2, indicates lineage number in Fig. 2 and Tabl. 2), *C. roesleri* (3)) and central and eastern Laos (*C. lomyenensis* (6) and *C. teyniei* (7) from Khammouane Province, *C. pageli* (9) from Vientiane Province). The latter species, *C. pageli* (lineage 9) appears to be more distantly related to others, though its' phylogenetic position is recovered in alternative ways in ML and BI analyses (always with non-significant values of node support).

(4) The sample IEBR A.2013.112 from Khammouane Province in Laos, indicated as "*Cyrtodactylus* sp. 4" in the original publication by Schenider et al. (2014b) with absolute values of node support (BS/PP = 100/1.0) groups with samples of *C. roesleri* from Quang Binh Province, Vietnam (lineage 4 – *C.* cf. *roesleri* in Fig. 2). Certain level of genetic differentiation between this lineage and *C. roesleri* from the type locality (p = 6.12%, see Tabl. 2) may be explained by incomplete taxonomy of this group as well as by interspecific differentiation of local populations. Thus, our analysis confirms the presence of *C. roesleri* or a very closely related form of *Cyrtodactylus* in Laos; herein we tentatively indicate this lineage as *C.* cf. *roesleri*, further morphological examination and analysis of nuclear DNA markers might help to clarify the taxonomic status of this lineage.

(5) The three syntopic morpho-species of *Cyrtodactylus* found by us in limestone forests in the environs of Na Home, Khammouane Province, eastern Laos, group into three distantly related clades; all belonging to the *C. phongnhakebangensis* species group. Among them, clade 1 includes the sample IEBR A.2013.89, indicated as "*Cyrtodactylus* sp. 3" in the original publication by Schenider et al. (2014b), genetic distance from our samples is less than p = 1.0% (see Tabl. 2). This species is recovered as a sister-group of *C. phongnhakebangensis* from Quang Binh Province of Vietnam (see Fig. 2); it was indicated as "*Cyrtodactylus* sp. 3" (Schenider et al. 2014b) or as "*Cyrtodactylus* sp. 4" (Nguyen et al. 2014; please note that sample IDs and GenBank AN's are erroneously mixed in the Table 1 of this publication) by previous researchers. The uncorrected genetic distinace of the clade 1 from its sister species *C. phongnhakebangensis* reaches p = 9.34% (see Tabl. 2). Based on significant genetic distance in COI gene and morphological differences, below we describe the representatives of this clade as a new species, *Cyrtodactylus darevskii* sp. nov.

(6) The clade 5 also from Na Home Village in Khammouane Province of Laos forms a clearly distinct mtDNA lineage (see Fig. 2). This species was also included in the recent paper of Nguyen et al. (2014) where it was indicated as "*Cyrtodactylus* sp. 5" (Nguyen et al. 2014; please note that sample IDs and GenBank AN's are erroneously mixed in the Table 1 of this publication). Genetic differentiation of this lineage from other members of the *C. phongnhakeban-*

Table 2. Uncorrected *p*-distance (percentage) between COI sequences of studied *Cyrtodactylus* species (below diagonal), within group mean *p*-distances (on diagonal) and calculation errors (above diagonal).

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1. *C. darevskii* sp. nov.	0.99	1.14	1.66	1.54	1.45	1.52	1.46	1.53	1.40	1.63	1.72	1.63	1.79	1.62	1.61	1.66	1.59	1.65	1.68	2.19	1.73	1.72
2. *C. phongnhakebangensis*	9.34	0.00	1.60	1.64	1.50	1.54	1.42	1.52	1.54	1.66	1.76	1.75	1.71	1.63	1.67	1.68	1.67	1.90	1.71	2.13	1.77	1.64
3. *C. roesleri*	17.23	15.33	0.24	1.11	1.68	1.69	1.46	1.53	1.65	1.53	1.60	1.70	1.69	1.78	1.78	1.74	1.65	1.50	1.78	2.35	1.81	1.73
4. *C.* cf. *roesleri*	15.93	16.36	6.12	—	1.67	1.71	1.49	1.52	1.61	1.51	1.56	1.75	1.57	1.79	1.75	1.70	1.65	1.46	1.77	2.36	1.91	1.82
5. *C. khammouanensis* sp. nov.	14.93	15.54	16.42	16.69	0.10	1.49	1.51	1.55	1.46	1.47	1.50	1.67	1.61	1.61	1.57	1.65	1.66	1.75	1.63	2.10	1.57	1.75
6. *C. lomyenensis*	14.56	14.69	17.67	17.97	15.60	0.12	1.30	1.35	1.33	1.47	1.55	1.79	1.62	1.65	1.56	1.63	1.60	1.65	1.71	2.04	1.65	1.75
7. *C. teyniei*	15.34	15.27	17.52	17.82	17.18	14.57	0.00	0.86	1.50	1.56	1.46	1.64	1.62	1.64	1.55	1.71	1.64	1.56	1.76	2.32	1.64	1.70
8. *C. multiporus* sp. nov.	15.45	15.27	16.97	17.09	16.57	14.39	6.00	0.00	1.56	1.54	1.45	1.65	1.62	1.65	1.57	1.69	1.58	1.59	1.77	2.35	1.68	1.65
9. *C. pageli*	17.74	17.64	17.52	16.73	18.59	17.06	17.64	17.45	—	1.41	1.41	1.69	1.45	1.60	1.62	1.72	1.70	1.57	1.91	2.01	1.57	1.70
10. *C. puhuensis*	22.88	21.45	19.73	20.09	22.09	21.10	20.91	21.36	20.09	3.27	0.96	1.33	1.49	1.57	1.52	1.38	1.33	1.44	1.49	1.77	1.45	1.77
11. *C. vilaphongi*	20.48	20.55	20.55	20.00	21.85	20.95	18.36	19.64	19.27	9.45	0.00	1.27	1.47	1.51	1.51	1.39	1.50	1.43	1.55	1.91	1.52	1.67
12. *C. spelaeus* sp. nov.	23.53	20.79	20.00	20.00	21.65	23.38	21.03	21.21	21.45	11.48	12.30	0.61	1.49	1.51	1.50	1.61	1.49	1.68	1.71	1.97	1.68	1.82
13. *C.* sp. 2 Luang Prabang	20.71	18.73	20.24	19.27	19.32	19.98	21.64	21.27	20.36	15.00	13.45	14.48	0.00	1.49	1.57	1.49	1.62	1.56	1.50	1.91	1.65	1.70
14. *C. martini*	21.82	18.91	20.48	20.91	20.26	22.04	22.36	22.18	19.45	17.18	15.45	15.39	14.55	—	0.97	1.58	1.57	1.70	1.60	2.03	1.53	1.62
15. *C. wayakonei*	21.05	19.91	21.58	20.91	20.54	21.40	22.45	22.27	20.55	18.23	16.55	16.67	16.09	6.82	0.91	1.64	1.50	1.71	1.61	2.07	1.67	1.68
16. *C. cryptus*	20.61	19.64	22.24	20.73	20.69	20.58	20.36	20.36	19.64	20.00	18.73	19.94	20.55	19.27	18.55	0.00	1.23	1.40	1.46	1.78	1.41	1.88
17. *C.* sp. 1 Da Nang	22.36	20.36	21.15	21.82	22.55	21.31	20.18	19.64	20.00	18.73	17.82	19.39	19.09	17.45	18.18	9.27	—	1.44	1.31	1.79	1.41	1.68
18. *C. irregularis*	22.24	21.39	22.12	20.97	22.91	21.62	21.39	22.30	21.52	20.52	18.42	22.06	19.52	19.88	19.52	16.06	15.52	0.12	1.54	1.81	1.36	1.79
19. *C. taynguyenensis*	21.64	21.09	23.27	21.45	20.87	20.58	20.36	22.00	22.36	20.00	19.27	20.55	21.09	19.64	18.82	15.09	15.82	16.61	0.00	1.42	1.24	1.79
20. *C.* cf. *pseudoquadrivirgatus*	22.75	19.73	22.07	22.70	21.08	20.33	21.89	21.62	20.54	19.59	19.73	20.81	19.46	17.57	18.92	15.68	13.24	13.78	10.27	—	1.37	2.19
21. *C. pseudoquadrivirgatus*	20.63	19.82	21.15	22.00	20.20	21.74	20.00	21.64	20.91	18.36	18.36	19.58	21.27	17.27	17.82	13.27	14.55	13.70	12.73	8.11	0.00	1.67
22. *Gekko gecko*	23.09	22.36	23.09	23.27	22.67	22.89	24.91	23.82	26.00	23.09	24.00	24.61	23.09	22.91	23.36	24.00	24.18	25.39	25.64	24.86	25.09	—

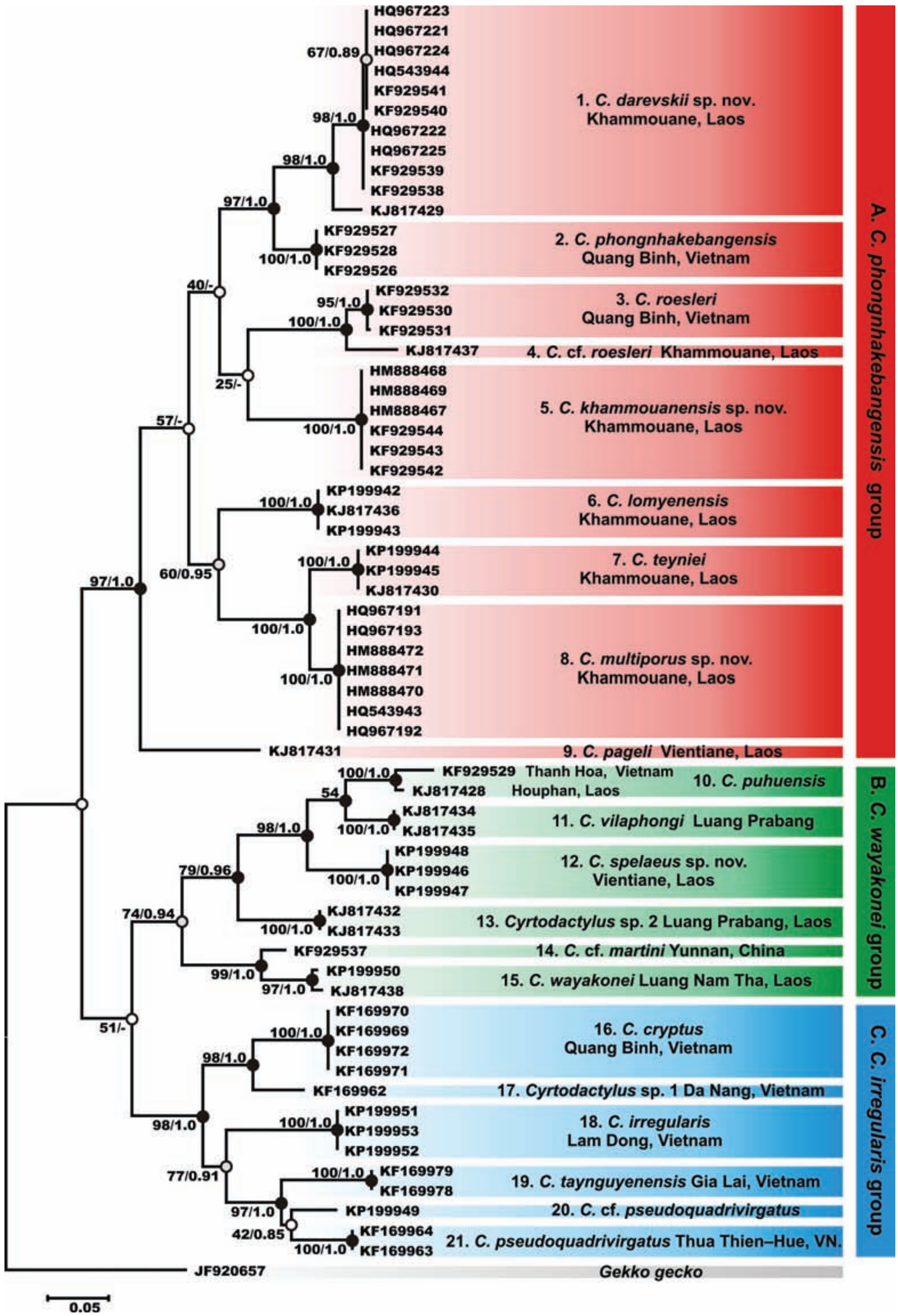


Fig. 2. ML-tree of studied *Cyrtodactylus* species based on the analysis of 673 bp of COI mtDNA gene. Node colour indicates support value: black for well-supported and sufficiently supported nodes (ML BS > 90%; BI PP > 0.95), greyfor moderately or poorly supported nodes and white for unresolved nodes with low or no support. Bootstrap support (BS) and posterior probability (PP) values are shown above or below tree nodes for ML/BI analyses respectively. Genbank accession numbers of samples corresponds to those in Table 1.

gensis species group is significant, with minimal p-distances found between this species and *C. roesleri* from Quang Binh Province of Vietnam and Khammouane Province of Laos (p = 16.42–16.69%, see Tabl. 2). Based on high genetic distances between COI gene sequences and significant morphological differences, below we describe the members of this clade as a new species, *Cyrtodactylus khammouanensis* sp. nov.

(7) The members of the clade 8 from environs of Na Home Village in Khammouane Province of Laos form a significantly supported monophyletic group with another Laotian species *C. teyniei* (see Fig. 2), which also inhabits limestones of Khammouane Province (see Fig. 1). These lineages appear to be very close with minimal uncorrected genetic distance observed between them: p = 6.00%. The genetic distances of this lineages from another limestone species from the Khammouane Province, *C. lomyenensis*, is much grater (p = 14.39–14.57%, see Tabl. 2). However, stable differences in unique states of morphological features (see below) allow us to designate this lineage as a new species, *Cyrtodactylus multiporus* sp. nov.

(8) Monophyly of the group B, encompassing limestone and cave species of *Cyrtodactylus* from central, western and northern Laos and adjacent China, is moderately supported (BS / PP = 74/0.94); tentatively we indicate it as *C. wayakonei* species group (see Fig. 2). This group is subdivided into two subclades, one joining *C. wayakonei* from northern Laos and *Cyrtodactylus* sp. from Xishuangbanna (which, based on preliminary examination of vouchers, we tentatively indicate here as *C.* cf. *martini*) and the second one, joining all other species. Among the latter, the sample *Cyrtodactylus* from Houphan Province in Laos (IEBR A.2013.109) indicated as "*Cyrtodactylus* sp. 1" in the original publication by Schenider et al. (2014b) is undoubtedly with absolute levels of statistical support (BS/PP = 100/1.0) conspecific with the recently described *C. puhuensis* from Thanh Hoa Province of Vietnam (see Fig. 2). Genetic differentiation between Laotian and Vietnamese populations of this species is minimal (p = 3.27%; see Tabl. 2); thus our analysis provides evidence for including *C. puhuensis* in the herpetofaunal list of Laos. The species appears to be closely related to *C. vilaphongi* from Luang Prabang Province in north-central Laos (p = 9.45%, see Tabl. 2).

(9) The species indicated as "*Cyrtodactylus* sp. 2" in the original publication by Schenider et al. (2014b) appears to be quite distant from other members of the group (p = 13.45–15.00%, see Tabl. 2). The population of cave-dwelling *Cyrtodactylus* from Khuang Lang N.P., Kasi District, Vientiane Province, also appears to be quite distant from other members of *C. wayakonei* species group (p = 11.48–11.48%). Based on distinct morphological differences and significant differentiation in mtDNA we below describe this species as *Cyrtodactylus spelaeus* sp. nov.

(10) The members of the clade C belong to the *C. irregularis* species group, which in our analysis includes only central-Vietnamese taxa: *C. cryptus* from Quang Binh Province, *Cyrtodactylus* sp. 1 from Da Nang, *C. irregularis* from Lam Dong Province, *C. taynguyenensis* from Gia Lai Province, *C.* cf. *pseudoquadrivirgatus* and *C. pseudoquadrivirgatus* from Thua Thien – Hue Province. Phylogenetic relationships between these closely-related taxa in general correspond to those reported by previous researchers (Nazarov et al. 2012; Nguyen et al. 2013, 2014).

Taxonomic accounts

Cyrtodactylus darevskii sp. nov.
(Fig. 3)

Holotype. Adult male ZMMU R-13980 (field number F185) collected on 18 June 2009 by Nikolai Orlov, Sang Ngoc Nguyen and Konstantin Milto in environs of Na Phao Village, Boulapha District, Khammouane Province, Laos (17°34´57.1´´N and 105°44´37.3´´E; elevation 170 m a.s.l.).

Paratypes. Three adult males (ZMMU R-13981-1; 13981-2 (FN 186, 187); ZIN 28247 (FN 256), two adult females (ZMMU 13981-3 (1999); ZIN 28248 (FN 188) and one subadult ZIN 28249 (FN 189). All members of the type series with the same collection data as the holotype.

Diagnosis. A large sized, slender *Cyrtodactylus* with a maximum SVL of 100 mm; the new species is distinguished from all congeners by the following morphological characters. Dorsal color pattern consisting of narrow dark nuchal band and 4–5 dark transversal breaking bands with light yellowish edge between limbs and 8–10 transversal dark bands on the tail. Dorsal surface of head very light brown, sometimes with a yellowish tinge, with few small irregular roundish dark brown spots. Dorsal of head and temporal region, body, hind limbs and base of tail covered by rounded, keeled tubercles, which are 2–3 times larger than the surrounding scales. Ventrals in

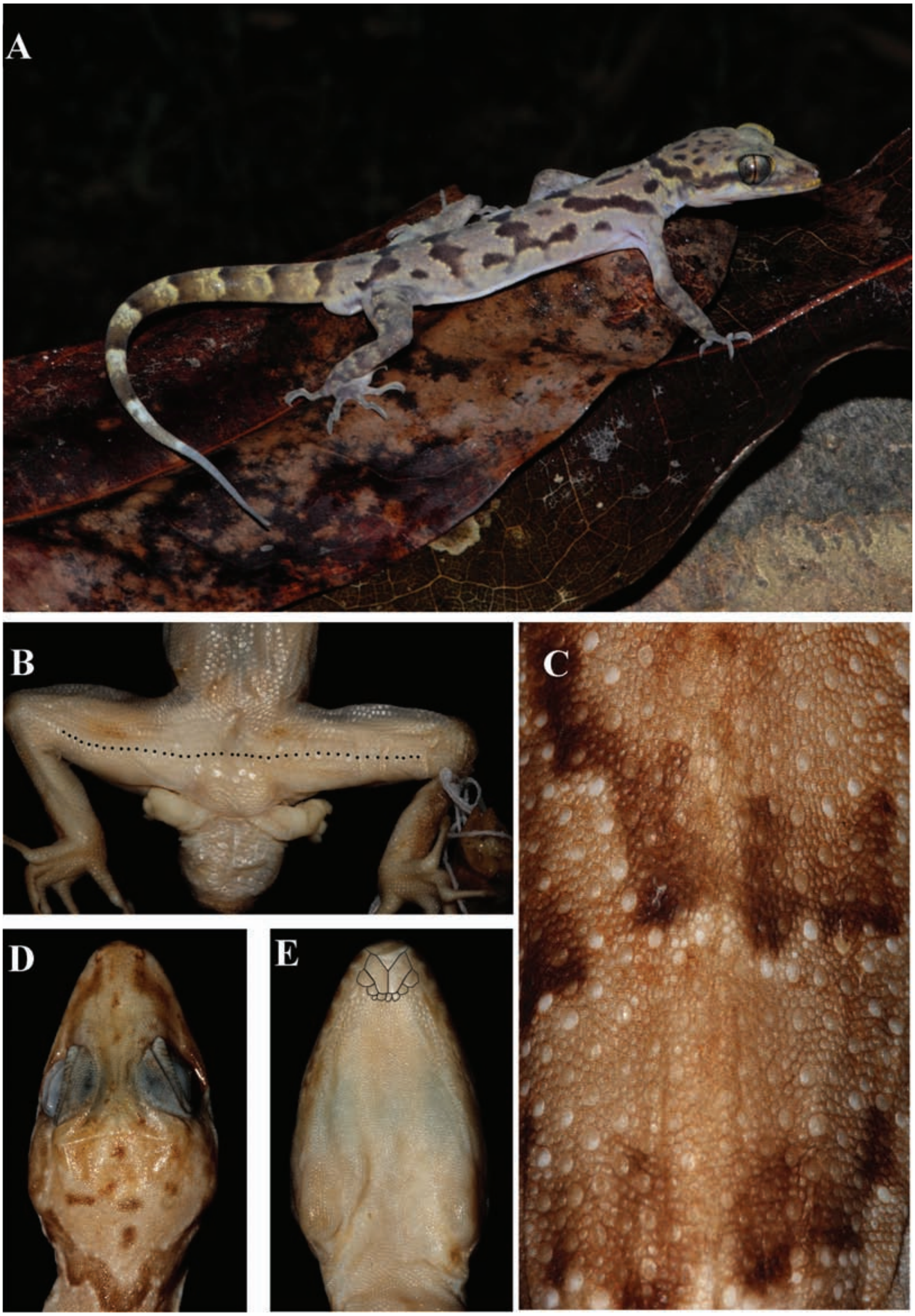


Fig. 3. *Cyrtodactylus darevskii* sp. nov.: A – general view of holotype; B – precloacal region with continuous row of femoral and precloacal pores; C – dorsum surface with the rows of enlarged tubercles; D – dorsal surface of the head; E – ventral surface of the head with mental scalation.

38–46 longitudinal rows at midbody, lateral folds are not strongly developed. Continuous series of 38–44 precloacal and femoral pores in males and 24–34 precloacal and femoral pores in females. Subcaudals in transversally enlarged median row, flat, smooth, imbricate. No enlarged keeled tubercles on the dorsal surface of the tail; 4–5 postcloacal spurs in both sexes.

Holotype description. The holotype is an adult male, in good state of preservation; it has the following measurements: SVL 90.0 mm, TailL 105.0 mm, HeadL 24.8 mm, HeadW 15.8 mm, HeadH 9.7 mm , SnEye 10.5 mm, OrbD 5.5 mm, EarL 2.2 mm, EyeEar 6.2 mm; proportions are as follows: SVL/HeadL 3.62, HeadL/HeadW 1.56, HeadL/HeadH 2.55, SnEye/EyeEar 1.69.

Rostral is large, wider than high (RW 3.9 mm, RH 2.2 mm, RW/RH 1.77) with an inverse Y–shaped median suture; supralabials 10/10; infralabials 9/10; nares surrounded by rostral anteriorly, first supralabial laterally, supranasal and two nasals posteriorly; rostral about 4–5 times larger than supranasal; supranasals in broad contact with each other; upper anterior ciliaries two times larger than posterior ones; head scales granular, two times smaller than the median snout scales; no enlarged keeled tubercles on the dorsal surface of head (Fig. 3d); on temporal region enlarged tubercles are present, they are 3–4 times larger than the surrounding scales; mental triangular, as wide as rostral; two pairs of enlarged postmentals, first pair longer than wide and in broad contact (Fig. 3e); dorsal scales granular, 3–4 times smaller than the ventral scales; dorsal tubercles round, flat, keeled, surrounded by 8–10 granular scales, tubercles forming about 18 irregular longitudinal rows at midbody (Fig. 3c); ventral scales smooth, 38 longitudinal rows at midbody; lateral folds weakly developed; dorsal surface of fore limbs without enlarged tubercles and hind limbs with smooth roundish enlarged tubercles; fingers and toes without web, basal lamellae more rounded than on distal surface of digits; row of enlarged femoral and precloacal scales with 43 pores, (Fig. 3b); fore pairs of enlarged postcloacal spurs; dorsal of tail without enlarged keeled tubercles; posterior part of tail covered by flattened and rounded scales; subcaudals with enlarged median plate row, flat, smooth, imbricate, twice wider than high.

Coloration: Dorsal surface of head is light brown with the few roundish small dark irregular dots; nuchal band not wide with undulating edge posteriorly, dark brown with a distinct light margin, extending from the neck to the posterior margins of eyes; labials are light grey. Dorsal color pattern formed by five transversal dark brown bands with light yellowish edge between limbs. Dorsal surface of limbs and digits light brown or yellowish with unclear dark bands. The lower surfaces of toes and fingers are light grey. Tail with eight, wide, dark brown bands, which are wider than the light grey interceptions in-between. Ventral body surfaces white, tail dark with light spots. For coloration in life see Fig. 3a.

Variation of paratypes. For the variation of the type series see Table 3. The dorsal pattern is somewhat variable. Sexual dimorphism is not well developed, males somewhat smaller than females, maximal SVL for males is 93.2 mm and for females is 100 mm. Precloacal and femoral pores present in both sexes, but males have more developed postcloacal spurs.

Comparisons with Laotian congeners. Below we compare the new species with eleven Laotian congeners. *Cyrtodactylus darevskii* sp. nov. differs from *C. buchardi* David, Teynie et Ohler, 2004 by the singe median row of subcaudals (vs. subcaudals not enlarged in *C. buchardi*), enlarged femoral scales (lacking in *C. buchardi*), fewer dorsal tubercle rows (16–20 vs. 25), more ventral scales (38–46 vs. 30), and more subdigital lamellae under the fourth finger and toe (17–20 and 18–22 vs. 14 and 12).

From *C. interdigitalis* Ulber, 1993 new species differs by transversal enlarged subcaudal scales; higher number of precloacal and femoral pores in the singe row (38–44 for males and 24–38 for females vs. 14 precloacal and 9+9 femoral pores for *C. interdigitalis*); roundish tail *versus* flattened tail; dorsal patterns of new species consisting of 4–5 dark transverse narrow bands *versus* 4–5 wide brownish jagged transversal bands; no webbing between toes *versus* developed web on the basis of toes. *Cyrtodactylus darevskii* sp. nov. can be distinguished from *C. jaegeri* Luu, Calame, Bonkowski, Nguyen et Ziegler, 2014 by larger body size (maximum SVL 100 mm vs. 68.5 mm), a higher number of ventral scales (38–46 vs. 31–32), dorsal color patterns (dark narrow transverse wavy bands vs. wide transversal dark bands). The new species is distinguished from *C. jarujini* Ulber, 1993 by having smaller number of femoral and precloacal pores arranged in a continuous row (38–44 vs. 52–54 pores in an irregular row), more ventral scales (38–46 vs. 30–38), and also can be further distinguished by number of subdigital lamellae (LF4 17–20 and LT4 18–22 vs. 12–17 and 11–18 respectively). The new

Table 3. Measurements and selected morphological characters of the type series of *Cyrtodactylus darevskii* sp. nov.; f = female, m= male, sub = subadult.

	Holotype	Paratypes					
	ZMMU R-13980	ZMMU R-13981-2	ZMMU R-13981-1	ZIN 28247	ZMMU R-13981-3	ZIN 28248	ZIN 28249
Sex	m	m	m	m	f	f	sub
SVL	90	93.2	90	73.7	100	84.6	50.6
TailL	105	*	113	95	*	45*	*
Head L	24.8	25.3	24.5	21.5	27.6	23.2	15.0
Head W	15.8	15.8	16	13	17.7	14.2	9.0
Head H	9.7	9.4	10	7.7	10.8	8.7	5.2
SnEye	10.5	10.6	10.3	8.6	11.2	9.0	4.7
OrbD	5.5	5.7	5.2	4.8	5.8	5.0	3.9
EarL	2.2	2.6	1.8	2.0	2.7	2.5	1.0
EyeEar	6.2	5.7	6.2	5.3	6.5	5.7	3.6
TrunkL	40.1	39.5	38.2	32.6	44.3	38	19.8
LS	15.5	16.1	15.3	12.9	16.7	14.2	7.8
ForeaL	14	14.8	14.4	11.5	15.3	13.2	7.2
FemurL	18.5	21	17.7	16.6	21.2	18.3	10.7
Crus L	14.7	17	15.3	12	16.2	13.8	8.3
LD4A	9.1	9.2	9.0	8.0	9.6	7.7	4.6
LD4P	9.8	12.4	11.7	9.7	12.0	10.5	5.7
V	38	43	40	40	44	46	40
SLB	193	194	216	180	192	208	190
LF 4	19	17	20	19	19	19	17
LT 4	20	18	20	18	22	20	18
PP+FP	43	44	38	38	34	24	0
SL	10	12	10	11	11	10	12
IL	9	10	10	9	10	9	11
TubL	42	43	43	40	44	48	38
TubW	18	16	16	20	16	18	18
SLH	93	97	95	85	90	91	94
SAH	78	72	82	71	74	75	80

species is distinguishable from *C. lomyenensis* Tri et Pauwels, 2010 by the larger body size (maximum SVL 100 mm vs. 72.1 mm in *C. lomyenensis*), a higher number of ventral scales (38–46 vs. 35–36), dorsal color pattern (narrow dark transverse bands vs. wide bands in *C. lomyenensis*). *Cyrtodactylus darevskii* **sp. nov.** can be further differentiated from *C. pageli* Schneider, Nguyen, Schmitz, Kingsada, Auer et Ziegler, 2011 by the following morphological attributes: continuous row of precloacal and femoral pores (38–44 vs. 4–6 precloacal pores in *C. pageli*), greater number of enlarged dorsal tubercle rows (16–20 vs. 9–14)*. From *C. roesleri* Ziegler, Nazarov, Orlov, Nguyen, Vu, Dang, Dinh et Schmitz, 2010 the new

*The number of pores in the single known female is ambiguously stated in the original description of *C. teyniei*; in Tab. 1 (p. 37, David et al. 2011) the number of pores is given as 13, whereas in the diagnosis on the page 30 and in the Fig. 3a of the same publication the number of pores is stated as 14.

species is distinguishable by having a higher number of precloacal and femoral pores (38–44 vs. 20–28), larger maximum body size (100 mm vs. 75.3 mm), dorsal pattern (irregular, dark transverse bands vs. wide transverse dark bands in *C. roesleri*). The new species differs from *C. teyniei* David, Nguyen, Schneider et Ziegler, 2011, by the higher number of pores in females (24–34 vs. 13 or 14), dorsal color pattern (narrow bands vs. blotches in *C. teyniei*), presence of nuchal loop (present in the new species vs. absent in *C. teyniei*). The new species can be further diagnosed from *C. puhuensis* Nguyen, Yang, Thi Le, Nguyen, Orlov, Hoang, Nguyen, Jin, Rao, Hoang, Che, Murphy et Zhang, 2014 by a higher number of precloacal and femoral pores (38–44 vs. 5 precloacal pores in *C. puhuensis*), and by a different dorsal pattern (dark transverse bands vs. light narrow bands in *C. puhuensis*). From *C. vilaphongi* Schneider, Nguyen, Duc Le, Nophaseud, Bonkowski et Ziegler, 2014 the new species differs by having enlarged median row of subcaudals (absent in *C. vilaphongi*), higher number of ventral scales (38–46 vs. 34–36 in *C. vilaphongi*) and different dorsal color pattern (dark transverse bands vs. narrow yellowish white bands in *C. vilaphongi*). *From C. wayakonei* Nguyen, Kingsada, Roesler, Auer et Ziegler, 2010 the new species is distinguished by a higher number of precloacal and femoral pores (38–44 vs. 6–8 precloacal pores), different dorsal pattern (dark bands vs. blotched to reticulated pattern in *C. wayakonei*), and by subcaudal scalation (enlarged median row of subcaudals vs. somewhat enlarged and broadened subcaudals).

Etymology. *Cyrtodactylus darevskii* sp. nov. is named for the honor of the famous Russian herpetologist Ilya Sergeevich Darevsky (1924–2009). The recommended vernacular name in English: Darevsky's Bent-toed Gecko.

Habitat description. The study area is located in environs of Na Phao Village, Boulapha District, Khammouane Province, eastern Laos. (17°34´57.1´´N and 105°44´37.3´´E, elevation 170 m a.s.l.). Field work was conducted there during 15–20 June, 2009. The study area is situated near Phou Hinboun (Limestone) National Biodiversity Conservation Protected Area. The area is dominated by sparsely vegetated limestone karst. *Cyrtodactylus darevskii* **sp. nov.** was found at the altitude 170 m a.s.l. in a karst cave (Fig. 8). All the geckos are found on the walls in small-sized caves. They are recorded at night near numerous cracks that serve as shelters. The new species was recorded in synbiotopy with *Cyrtodactylus khammouanensis* sp. nov. (see below).

Distribution. To date the new species is known only from the type locality.

Phylogenetic position. A member of *C. phongnhakebangensis* species group; most closely related to its sister species *C. phongnhakebangensis*, distributed in Quang Binh Province of Vietnam (p = 9.34%).

***Cyrtodactylus khammouanensis* sp. nov.**
(Fig. 4)

Holotype. Adult male ZMMU R-13982 (field number FN 192) collected on 16 June 2009 by Nikolai Orlov, Sang Ngoc Nguyen and Konstantin Milto in the environs of Na Phao Village, Boulapha District, Khammouane Province, Laos (17°34´57.1´´N and 105°44´37.3´´E, elevation 170 m a.s.l.).

Paratypes. One adult male ZIN 28250 (FN 193) and two adult females ZMMU R-13983 (FN 257); ZIN 28251 (FN 191). All type specimens are with the same data as the holotype.

Diagnosis. Relatively small *Cyrtodactylus* with a maximum SVL of 73 mm; the new species is distinguished from all other congeners by the combination of the following morphological characters. Dorsal pattern consisting of wide dark nuchal band and 4–5 dark wide transverse bands with smooth edges. Widths of interspaces between dorsal bands are less than widths of the bands. Dorsal surface of head is light yellowish, without any clear pattern. Dark wide transverse bands present on the tail. Roundish weakly keeled tubercles present on the dorsum, hind limbs, temporal region of the head, on the tail base and absent on the dorsal surface of the head. Ventrals in 32–38 longitudinal rows at midbody. Lateral folds weakly developed. Continuous series of 40–44 precloacal and femoral pores in males reach the bend of knee. Enlarged femoral scales present, 5–6 enlarged postcloacal spurs in both sexes. Subcaudal scales transversally enlarged in one median row.

Holotype description. *Cyrtodactylus khammouanensis* sp. nov. – adult male, the holotypehas the following measurements: SVL 70.8 mm, TailL 95.0 mm, HeadL 19.8 mm, HeadW 12.2 mm, HeadH 7.4 mm , SnEye 7.5 mm, OrbD 4.4 mm, EarL 2.0 mm, EyeEar 5.2 mm; proportions are as follows: SVL/HeadL 3.57, HeadL/HeadW 1.62, HeadL/HeadH 2.67, SnEye/EyeEar 1.44.

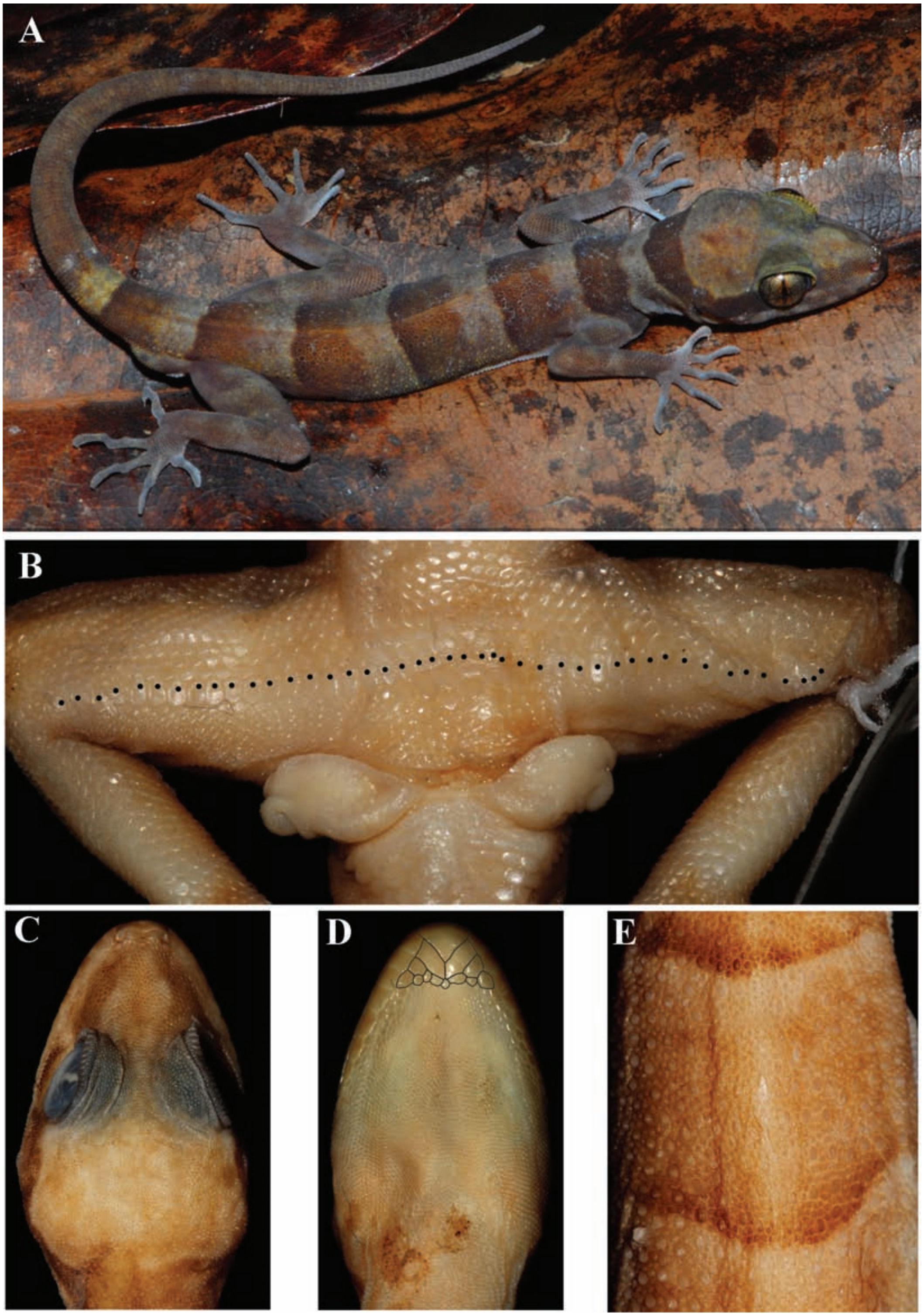


Fig. 4. *Cyrtodactylus khammouanensis* sp. nov.: A – general view of type specimen; B – precloacal region with continuous row of femoral and precloacal pores; C – ventral surface of the head with mental scalation; D – dorsal surface of the head without enlarged tubercles; E – dorsum surface with the rows of enlarged tubercles.

Rostral large, somewhat wider than high (RW 3.0 mm, RH 1.9 mm, RW/RH 1.57) with an inverse Y-shaped median suture; supralabials 12/12; infralabials 10/11; nares surrounded by rostral anteriorly, first supralabial laterally, supranasal and two nasals posteriorly; rostral about 7–8 times larger than supranasal; supranasals in contact with each other; dorsum of head covered by small granular scales without enlarged keeled tubercles (Fig. 4c); on the temporal region rounded, weakly keeled tubercles, which are ca. three times larger than the surrounding scales, are present; mental pentagonal, as wide as rostral; two pairs of enlarged postmentals, first pair longer than wide in broad contact (Fig. 4d); dorsal scales granular, 2–3 times smaller than the ventral scales; dorsal tubercles not large (3–4 times larger than the surrounding scales), conical, weakly keeled, surrounded by 8–10 granular scales, tubercles forming about 18 irregular longitudinal rows at midbody (Fig. 4e); ventral scales smooth, 38 longitudinal rows at midbody; lateral folds weakly developed; dorsal surface of forelimbs without enlarged tubercles and hindlimbs with smooth roundish enlarged tubercles; fingers and toes without web, basal lamellae more rounded than on distal surface of digits; row of enlarged precloacal and femoral scales with 44 pores (Fig. 4b); five pairs of enlarged postcloacal spurs; dorsal surface of tail without enlarged keeled tubercles; posterior part of tail covered by flattened and rounded scales; subcaudals flat, smooth, imbricate, with enlarged median plate row, about two times wider than high.

Coloration: Dorsal head surface light without any markings; nuchal band broadened posteriorly, dark brown with distinct white margin, extending from the neck to the posterior edges of eyes; labials light with brown spots. Dorsum brownish with six wide regular, dark, transverse bands with light posterior margins; flanks grayish white. Venter white, the lower side of toes and fingers light colored; dorsal surface of limbs and digits brownish without any contrasting markings. Dorsal surface of tail with 3 dark brown bands which are wider than the light bands in-between. Ventral sides of tail dark grey. For coloration in life see Fig. 4a.

Variation of paratypes. For the variation of the type series see Table 4. The dorsal pattern is nt variable. Sexual dimorphism is pronounced, precloacal and femoral pores present in males only; males also have better developed postcloacal spurs.

Comparisons with Laotian congeners. *Cyrtodactylus khammouanensis* sp. nov. differs from *C. buchardi* by the singe median row of subcaudals (vs. subcaudals not enlarged in *C. buchardi*), enlarged femoral scales (lacking in *C. buchardi*), fewer dorsal tubercle rows (16 or 21 vs. 25), greater number of ventral scales (32–38 vs. 30), and greater number of subdigital lamellae under the fourth finger and toe (18 or 20 and 20–23 vs. 14 and 12, respectively), moreover, dorsal pattern of the new species consists of six wide regular, dark, transverse bands *versus* five transverse series of irregular blotches in *C. buchardi*. From *C. interdigitalis* the new species clearly differs by transverse enlarged subcaudal scales; higher number of precloacal and femoral pores in the singe row (40–44 in the new species vs. 14 precloacal and 9+9 femoral pores in *C. interdigitalis*); roundish tail *versus* flattened tail; dorsal pattern of the new species consists of six wide regular, dark, transverse bands *versus* 4–5 wide brownish transverse bands with jagged edges; no webbing between toes *versus* developed web on the basis of toes. *Cyrtodactylus khammouanensis* sp. nov. seems to be closely related to recently described *C. jaegeri* and differs from this species by the following combination of morphological attributes: the new species has small smooth and round dorsal tubercles in 16–21 irregular longitudinal rows at midbody, which are not present on the occipital region *versus* round conical dorsal tubercles in 15–17 irregular longitudinal rows which continue on the occipital region, the new species has yellowish head coloration with a wide nuchal loop (approximately the same size as transverse bands, located posteriorly) *versus* light brown head with narrow nuchal loop (notably more narrow than the subsequent transverse dorsal bands), somewhat greater number of ventral scales (32–38 vs. 31–32). These two species can be further diagnosed by body and head proportions: the new species has relatively smaller head (SVL/HL 3.57 vs. 3.27); comparatively smaller orbit (HL/OrbD 4.5 vs. 3.89) and comparatively larger temporal region (HL/EyeEar 3.8 vs. 4.81). The new species differs from *C. jarujini* by the smaller body size (73 mm vs. 90 mm in *C. jarujini*), lesser number of femoral and precloacal pores (40–44 vs. 52–54), dorsal color pattern (banded vs. blotched in *C. jarujini*). The new species is similar to *C. lomyenensis* but is distinguishable from it by the following combination of morphological characters: lesser number of dorsal tubercle rows (16–21 vs. 20–24), continuous row of femoral and precloacal pores

Table 4. Measurements and selected morphological characters of the type series of *Cyrtodactylus khammouanensis* sp. nov.; f = female, m= male.

	Holotype	Paratypes		
	ZMMU R-13982	ZIN 28250	ZMMU R-13983	ZIN 28251
Sex	m	m	f	f
SVL	70.8	73	72	68.5
TailL	95	83	90*	*
Head L	19.8	20.0	19.2	19.3
Head W	12.2	12.2	12	12.5
Head H	7.4	7.6	7.5	8.0
SnEye	7.5	7.8	7.7	7.2
OrbD	4.4	4.8	4.8	4.3
EarL	2.0	2.1	1.8	2.0
EyeEar	5.2	4.7	4.7	4.8
TrunkL	30.7	30.8	32	29
LS	11.6	11.6	11	11.8
ForeaL	10.8	10.7	11	10.5
FemurL	16.5	14.8	15.2	15
Crus L	12.7	12.3	12	11.7
LD4A	6.6	6.2	7.2	6.4
LD4P	8.7	9.3	8.2	8.6
V	38	32	34	36
SLB	169	172	159	155
LF 4	18	19	20	19
LT 4	20	22	22	23
PP+FP	44	40	0	17
SL	12	11	11	11
IL	10	10	10	9
TubL	37	48	47	45
TubW	18	16	21	19
SLH	87	83	87	77
SAH	63	66	57	56

reaching the bend of knee *versus* not reaching at one third in *C. lomyenensis*, and dorsal pattern (bands with smooth margins vs. bands with wavy margins); furthermore, the new species has relatively smaller orbit (HL/OrbD 4.5 vs. 3.75) and relatively larger temporal region (HL/EyeEar 3.8 vs. 3.3). *Cyrtodactylus khammouanensis* sp. n. differs from *C. pageli* by the following characters: continuous row of precloacal and femoral pores (40–44 vs. 4–6 precloacal pores), lesser number of ventral scale rows (32–38 vs. 41–46), greater number of enlarged dorsal tubercle rows (16–21 vs. 9–14), and the dorsal pattern (bands with smooth margin vs. bands with wavy margins in *C. pageli*). The new species is distinguishable from *C. roesleri* by having a greater number of precloacal and femoral pores (40–44 vs. 20–28) and by dorsal pattern (the width of dorsal transverse bands is greater than the widths of interspaces between them vs. the width of dorsal bands is less than of the interspaces in-between). The new species differs from *C. teyniei* by smaller body size (maximum SVL 73 mm vs. 89.9 mm in *C. teyniei*), dorsal pattern (bands vs. blotched pattern in *C. teyniei*), nuchal loop (present vs. absent in *C. teyniei*). The new species is distinguished from

C. puhuensis by having greater number of precloacal and femoral pores (40–44 vs. 5 precloacal pores in *C. puhuensis*), and by a different dorsal color pattern (dark broad bands vs. light narrow bands).

From *C. vilaphongi*, the new species can be distinguished by having an enlarged median row of subcaudals and a different dorsal color pattern (dark broad bands vs. narrow yellowish white bands in *C. vilaphongi*). From *C. wayakonei* the new species is *distinguished* by having a greater number of precloacal and femoral pores (40–44 vs. 6–8 precloacal pores), by having a different dorsal color pattern (dark broad bands on the dorsum and no patterns on the head vs. head and dorsum with blotched to reticulated pattern in *C. vilaphongi*), and by differences in subcaudal scalation (distinctly enlarged median row of subcaudals vs. somewhat enlarged and broadened subcaudals in *C. vilaphongi*). *Cyrtodactylus khammouanensis* **sp. nov.** differs from *Cyrtodactylus darevskii* sp. nov. by smaller body size (maximum SVL 73 mm vs. 100 mm in *C. darevskii* sp. nov.), fewer numbers of ventral scales (32–38 vs. 38–46) and dorsal color pattern (wide transverse bands vs. narrow transverse bands).

Etymology. The specific epithet of the new species is derived from the name of Khammouane Province of Laos, renowned for its great diversity of *Cyrtodactylus* geckoes. Suggested common name in English: Khammouane Bent-toed Gecko.

Habitat description. The new species was recorded in the environs of Na Phao Village, Boulapha District, Khammouane Province, eastern Laos. (17°34´57.1´´N and 105°44´37.3´´E, elevation 170 m a.s.l.). Field work was conducted in this area during 15–20 June, 2009. The study area is situated near Phou Hinboun (Limestone) National Biodiversity Conservation Protected Area. The area is dominated by sparsely vegetated limestone karst. *Cyrtodactylus khammouanensis* sp. nov. was found at the altitude 170 m a.s.l. in a karst cave (Fig. 8). All specimens were found on the walls of the cave; the new species shares this habitat with *Cyrtodactylus darevskii* sp. nov.

Distribution. The new species is to date known only from the envrions of the type locality.

Phylogenetic position. A member of *C. phongnhakebangensis* species group; most closely related to *C. roesleri*, distributed in Quang Binh Province of Vietnam and Khammouane Province of Laos (p = 16.42–16.69%).

Cyrtodactylus multiporus **sp. nov.**
(Fig. 5)

Holotype. Adult male ZMMU R–13984 collected on 19 June 2009 by Nikolai Orlov, Sang Ngoc Nguyen and Konstantin Milto in the environs of Na Home Village, Boulapha District, Khammouane Province, eastern Laos (17°32´40.3´´N and 105°41´43.0´´E, elevation 230 m a.s.l.).

Paratypes. Two adult males ZMMU R–13985–1 (FN 4); ZIN 28252 (FN 3), six adult females ZMMU R-13985-2; 13985-3; 13985-4 (FN 5, 6, 7); ZIN 28253; 28254; 28255 (FN 1, 2, the third without field number), and three subadult specimens ZMMU R-13985-5 (FN 8); ZIN 28256; 28257 (FN 9, 10). All members of the type series have the same collection data as the holotype.

Diagnosis. Relatively large-sized species of *Cyrtodactylus* with a maximum SVL of 98 mm; the new species is distinguished from its congeners by a combination of the following morphological features. Dorsal pattern consisting of dark irregular separate spots and blotches between limbs and on the dorsal part of the head. The nuchal band is not developed, 6–8 dark wide transversal bands with irregular edges present on the dorsal surface of tail. Small smooth roundish dorsal tubercles present on the occipital region and sides of the head, body, hind limbs and the base of tail. Ventrals in 30–38 longitudinal rows at midbody. Continuous series of 58–60 precloacal and femoral pores in males, 5–6 postcloacal spurs in both sexes. Tail not segmented without whorls and keeled tubercles on its dorsal surface, one median row of transversally enlarged subcaudal scales.

Holotype description. Adult male, medium sized; the holotype has the following measurements: SVL 86.8 mm, TailL 95.0 mm, HeadL 24.2 mm, HeadW 15.3 mm, HeadH 9.0 mm , SnEye 9.6 mm, OrbD 5.8 mm, EarL 2.4 mm, EyeEar 5.0 mm; proportions are as follows: SVL/HeadL 3.58, HeadL/HeadW 1.58, HeadL/HeadH 2.68, SnEye/EyeEar 1.92. Rostral is large, somewhat wider than high (RW 4.0 mm, RH 2.25 mm, RW/RH 1.7) with an inverse T-shaped suture on the median part; supralabials 10/10; small scales between orbit and the seventh supralabial 4/4; infralabials 11/9; nares surrounded by rostral anteriorly, first supralabial laterally, supranasal and 3 nasals posteriorly; rostral about 7–8 times larger than supranasal; supranasals in contact to each other; upper anterior ciliaries two times larger than poste-

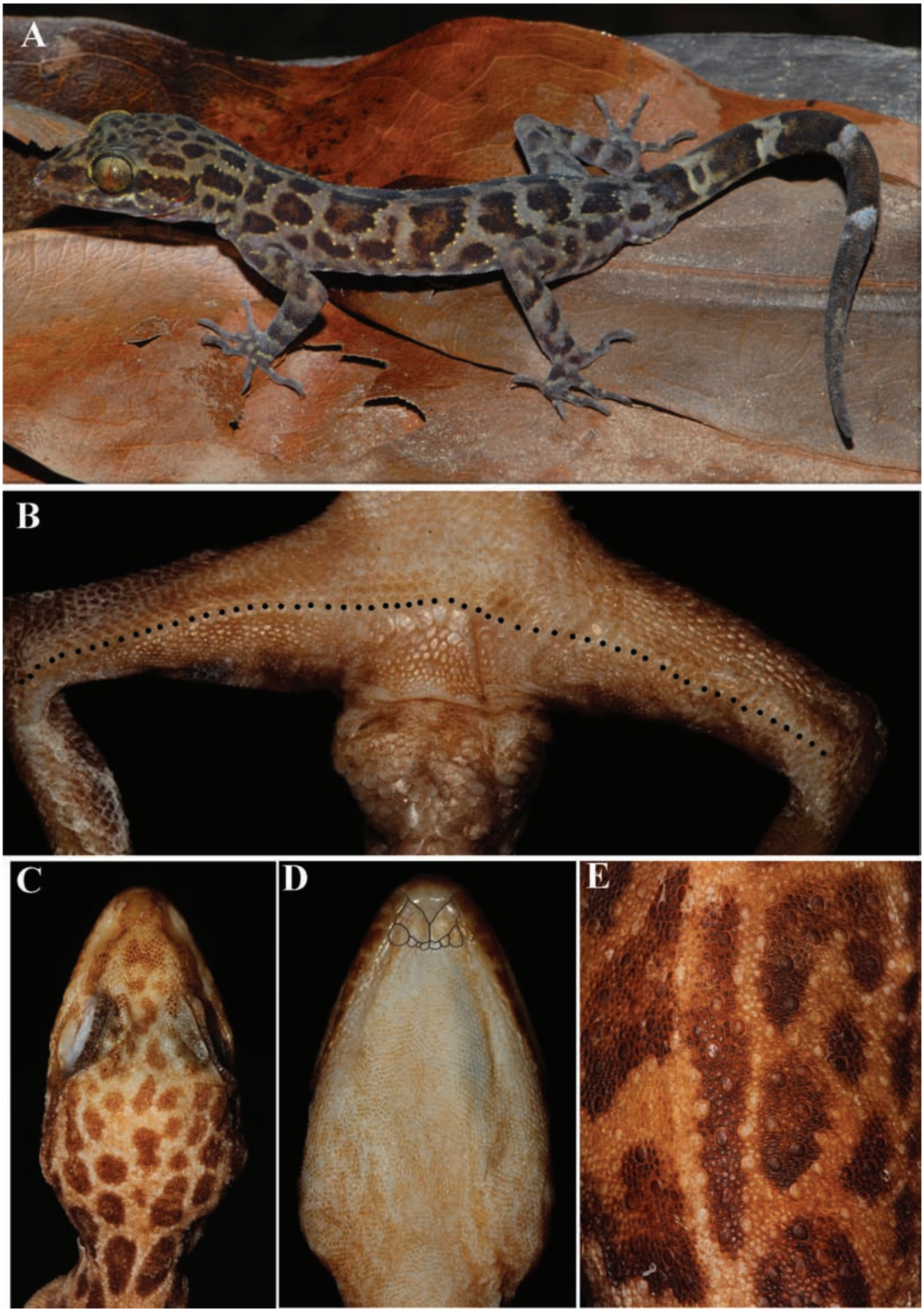


Fig. 5. *Cyrtodactylus multiporus* sp. nov.: A – general view of type specimen; B – precloacal region with continuous row of femoral and precloacal pores; C – ventral surface of the head with mental scalation; D – dorsal surface of the head with enlarged tubercles; e – dorsum surface with the rows of enlarged tubercles.

rior ones; head scales granular, some smaller than the median snout scales; dorsum of head and temporal region with rounded, keeled tubercles, that are 2–3 times larger than the surrounding scales (Fig. 5c); mental triangular; one pair of enlarged postmental, longer than wide, in broad contact (Fig. 5d); dorsal scales granular, 3–4 times smaller than the ventral scales; dorsal tubercles round, flat, not keeled, surrounded by 7–10 granular scales, tubercles forming about 20 irregular longitudinal rows at midbody (Fig. 5e); ventral scales smooth, 30 longitudinal rows at midbody; lateral folds weakly developed; dorsal surface of fore- and hindlimbs with granular scales and weakly keeled conical tubercles; fingers and toes without web, basal lamellae more rounded than on distal surface of digits; a row of precloacal scales with 58 pores (Fig. 5b); enlarged femoral scales (without pores) are present; five pairs of enlarged postcloacal spurs; not segmented tail without whorls and keeled tubercles on dorsal surface; subcaudals with row of enlarged plates, smooth and imbricate.

Coloration: Dorsal surface of head is light brown with small irregular rounded dark brown spots; continuous nuchal band not developed; labials brownish grey with white spots. Dorsal body surfaces brownish with dark irregular separate spots with light margins. Ventral surface is white, the lower side of toes and fingers grey; dorsal surface of limbs and digits brownish with irregular bands. First third of the tail with three dark brown bands; they are wider than the light-grey interspaces in-between them. Ventral side of tail dark brown with light spots that are becoming more distinct posteriorly. For coloration in life see Fig. 5a.

Variation of paratypes. For the variation of the type series see Table 5. The dorsal pattern is somewhat variable. Sexual dimorphism is well developed, males are smaller then females, maximal SVL for males is 86.8 mm and for females 98 mm; precloacal pores are present in males only and males have also more developed postcloacal spurs.

Comparisons with Laotian congeners. *Cyrtodactylus multiporus* sp. nov. differs from *C. buchardi* by the singe median row of subcaudals (vs. subcaudals not enlarged in *C. buchardi*), enlarged femoral scales (lacking in *C. buchardi*), fewer dorsal tubercle rows (16–20 vs. 25), more ventral scales (30–38 vs. 30), and more subdigital lamellae under the fourth finger and toe (18–20 and 18–22 vs. 14 and 12, respectively). From *C. interdigitalis* the new species is clearly different in having transversal enlarged subcaudal scales; higher number of precloacal and femoral pores in the singe row (58–60 in the new species vs. 32 precloacal and femoral pores in *C. interdigitalis*); roundish tail *versus* flattened tail; blotched irregular dorsal pattern *versus* 4–5 wide brownish jagged transversal bands; no webbing between toes *versus* developed webbing on the toe basis in *C. interdigitalis*.

Cyrtodactylus multiporus sp. nov. differs from *C. jaegeri* by larger body size (maximum SVL 98 mm vs. 68.5 mm); blotched dorsal patterns *versus* wide transversal bands; small, smooth and rounded dorsal tubercles in 16–20 longitudinal rows at midbody *versus* round conical dorsal tubercles in 15–17 longitudinal rows; in lacking a continuous nuchal loop *versus* distinct nuchal loop in *C. jaegeri*; somewhat greater number of ventral scales (30–38 vs. 31–32).

The new species is similar to *C. jarujini* by the body size and dorsal color pattern but can be diagnosed from this species by having a higher number of femoral and precloacal pores (58–60 pores in continuous row vs. 52–54 pores in irregular rows) and in having more subdigital lamellae (LF4 18–20 and LT4 18–22 vs. 11–17 and 11–18 respectively). From *C. lomyenensis the* new species differs by the larger body size (maximum SVL 98 mm vs. 72.1 mm in *C. lomyenensis*), a higher number of pores (58–60 vs. 32–40), lesser number of dorsal tubercle rows (16–20 vs. 20–24), and by dorsal color pattern (blotches vs. wide bands in *C. lomyenensis*). *Cyrtodactylus multiporus* sp. nov. can be differentiated from *C. pageli* by the following characters: a continuous row of precloacal and femoral pores (58–60 vs. 4–6 precloacal pores in *C. pageli*), lesser number of ventral scale rows (30–38 vs. 41–46), greater number of enlarged dorsal tubercle rows (16–20 vs. 9–14) and dorsal pattern (separate irregular spots vs. bands with wavy margins). The new species is distinguishable from *C. roesleri* by having a higher number of precloacal and femoral pores (58–60 vs. 20–28), a higher number of enlarged dorsal tubercle rows (16–20 vs. 10–12), by different dorsal pattern (blotches vs. wide dorsal bands in *C. roesleri*), by lacking nuchal band *versus* distinct nuchal loop in *C. roesleri*. The new species is morphologically similar to C. *teyniei* and can be distinguished from this species by lacking of femoral and precloacal pores in females *versus* 13 or 14 pores in the single known female of *C. teyniei*; by numeorus roundish dark spots on dorsal surface of head *versus* few dark spots on the head; by the dorsal color pattern having wide roundish dark blotches (vs. dorsal

Table 5. Measurements and selected morphological characters of the type series of *Cyrtodactylus multiporus* sp. nov.; f = female, m= male, sub = subadult.

	Holotype	Paratypes										
	ZMMU R-13984	ZIN 28252	ZMMU R- 13985-1	ZMMU R- 13985-2	ZMMU R- 13985-3	ZMMU R- 13985-4	ZIN 28253	ZIN 28254	ZIN 28255	ZMMU R- 13985-5	ZIN 28256	ZIN 28257
Sex	m	m	m	f	f	f	f	f	f	sub	sub	Sub
SVL	86.8	81.3	84.6	86.6	81	79.6	82	91	98	54.3	53.3	54
TailL	95*	85*	25*	105	98	97	102	100	76*	55	62	*
Head L	24.2	22.7	23.5	23.7	22.2	21.3	24	23.6	25.7	15.8	15.4	16.2
Head W	15.3	14.8	15.7	15.7	14.7	14.8	15.3	16.7	16.7	10	10.3	10.3
Head H	9.0	8.8	9.3	9.3	8.8	8.6	8.9	10	9.5	6.5	6.4	6.3
SnEye	9.6	9.1	9.3	9.4	8.8	8.4	8.8	9.8	10	6.3	6.2	6.3
OrbD	5.8	5.0	5.2	5.6	4.5	4.7	5.1	5.2	5.5	2.8	3.5	3.4
EarL	2.4	2.2	2.4	2.5	2.0	2.5	2.5	2.1	2.8	1.5	1.3	1.3
EyeEar	5.0	5.4	6.0	5.9	5.2	5.0	5.8	5.8	6.0	4.1	3.6	4.2
TrunkL	40.2	38.3	37.8	40.8	36.0	36	40.8	40.7	43.7	21.2	21.8	23.1
LS	15.2	14.5	14.1	14.5	12.9	13.2	13.8	14.7	15	9.4	8.6	9.2
ForeaL	13.2	12.8	13.2	13.5	12.5	12.0	12.7	13.6	13.3	8.7	8.0	8.2
FemurL	17.5	17.6	18.6	18.2	16.8	15	16.9	18.6	18.6	12.1	11.4	12.1
Crus L	14.1	13.6	14.2	14.8	13.0	12.8	13.5	14.0	14.4	9.0	9.4	9.6
LD4A	8.8	8.2	9.2	8.5	8.4	7.8	8.6	8.6	9.3	6.2	5.2	5.8
LD4P	11	9.5	9.6	10.4	9.5	10.0	9.6	9.8	10	6.7	6.6	6.3
V	30	30	36	37	36	34	36	38	34	34	37	32
SLB	174	168	168	178	173	177	180	171	181	177	164	174
LF 4	18	19	18	18	19	18	20	18	18	20	18	19
LT 4	22	19	22	21	19	18	20	19	18	22	19	20
PP+FP	58	60	58	0	0	0	0	0	0	0	0	0
SL	10	11	9	10	9	10	11	10	9	10	11	11
IL	11	11	10	10	9	9	11	10	9	10	10	10
TubL	42	44	42	41	41	34	45	43	42	45	41	40
TubW	20	18	20	20	18	16	18	18	18	18	18	18
SLH	89	93	96	94	88	81	96	89	86	92	89	100
SAH	89	76	72	79	75	68	83	78	76	73	70	80

pattern formed by thin and elongate blotches in *C. teyniei*). *The new species is distinguished from C. puhuensis* by having a higher number of precloacal and femoral pores (58–60 vs. 5 precloacal pores), and a different dorsal pattern (dark blotches vs. light narrow bands in *C. puhuensis*). From *C. vilaphongi* the new species difers in having an enlarged median row of subcaudals and a different dorsal color pattern (dark blotches vs. narrow yellowish white bands in *C. vilaphongi*). *From C. wayakonei* the new species is *distinguished* by having a higher number of precloacal and femoral pores (58–60 vs. 6–8 precloacal pores),

and different subcaudal scalation (distinctly enlarged median row vs. subcaudals somewhat enlarged, broadened in *C. wayakonei*). From *Cyrtodactylus darevskii* sp. nov. the new species differs in lacking of pores in females *versus* 24–34 pores in *C. darevskii* sp. nov. females; and also in higher number of pores in males (58–60 vs. 38–44), nuchal loop (absent vs. present in *C. darevskii* sp. nov.). The new species is distinguished from *Cyrtodactylus khammouanensis* sp. nov. by its larger body size (maximum SVL 98 mm vs. 73 mm in *C. khammouanensis* sp. nov.), and by higher number of pores (58–60 vs. 40–44).

Etymology. The species epithet "*multiporus*" is a Latin adjective in masculine, indicating the high number of precloacal and femoral pores typical for this species; derived from "*multus*" – "many" (Latin) and "*porus*" – "pore", "canal" (Latinized Greek).

Habitat description. The new species was recorded in a limestone forested area near Na Home Village in Boulapha District, Khammouane Province, eastern Laos (17°32´40.3´´N and 105°41´43.0´´E, elevation 230 m a.s.l.). Field work was conducted there during 15–19 June, 2009. The study area is situated near Phou Hinboun (Limestone) National Biodiversity Conservation Protected Area. The area is dominated by sparsely vegetated limestone karst (Fig. 9).

Distribution. At the present moment the new species is known only from the environs of the type locality.

Phylogenetic position. A member of *C. phongnhakebangensis* species group; very closely related to *C. teyniei*, also found in Khammouane Province of Laos; uncorrected genetic distance between *C. teyniei* and the new species comprise $p = 6.00\%$.

***Cyrtodactylus spelaeus* sp. nov.**
(Figs. 6–7)

Holotype. Adult male ZMMU R–14399 from Khuang Lang Cave National Park, Kasi District, Vientiane Province, Laos (18°09.876´N and 104°30.387´E, elevation 183 m a.s.l.). Collected on 22 November 2011 by E.L. Konstantinov and A.B. Gavrilov.

Paratypes. One adult female ZIN 28258 and one subadult male ZMMU R–14400. All specimens of the type series have the same collection data as the holotype.

Diagnosis. The new species of *Cyrtodactylus* with a maximum SVL of 91 mm, is distinguished from all other congeners by the following combination of morphological characteristics. Dorsal pattern formed by oblong dark irregular butterfly-shaped blotches (Fig. 6a), with light contrast margins and a light middorsal medial stripe running across them. Nuchal band with light edging consists of two separate parts, which contact in the occipital region. Dorsal head surface is light brown with roundish dark spots. The intact (not regenerated) tail with ten dark transverse bands. Roundish weakly keeled tubercles present on the dorsum, limbs, temporal region of the head and absent on the dorsal surface of the head. Ventrals in 36–39 longitudinal rows at midbody. Lateral folds weakly developed. Males with 8–9 precloacal pores in an angular continuous series. No femoral pores and enlarged femoral scales, 2–3 enlarged postcloacal spurs. One median row of transversally enlarged subcaudals.

Holotype description. The male of *Cyrtodactylus spelaeus* sp. nov. have the following measurements: SVL 88.9 mm, regenerated tail 80.1 mm, HeadL 26.3 mm, HeadW 16.9 mm, HeadH 10.8 mm , SnEye 10.2 mm, OrbD 5.6 mm, EarL 2.3 mm, EyeEar 8.0 mm; proportions are as follows: SVL/HeadL 3.38, HeadL/HeadW 1.55, HeadL/HeadH 2.43, SnEye/EyeEar 1.27.

Rostral large, somewhat wider than high (RW 3.9 mm, RH 2.5 mm, RW/RH 1.56) with a median groove; supralabials 12/11; infralabials 9/10; nares surrounded by rostral anteriorly, first supralabial laterally, supranasal and two nasals posteriorly; rostral about 5–6 times larger than supranasal; supranasals separated by one small scale from each other; dorsal surface of the head covered by small granular scales without enlarged tubercles (Fig. 7a); on the temporal region rounded, weakly keeled tubercles present; mental triangular, as wide as rostral; two pairs of enlarged postmentals, first pair in broad contact (Fig. 7b); dorsal scales granular, 2–3 times smaller than the ventral scales; dorsal tubercles smooth, rounded, not large (5–6 times larger than surrounding scales), surrounded by 8–9 granular scales; tubercles form ten irregular longitudinal rows at midbody (Fig. 7c); ventral scales smooth, 39 longitudinal rows at midbody; lateral folds weakly developed; dorsal surface of fore- and hindlimbs covered by smooth rounded enlarged tubercles; no webbing on fingers and toes, basal lamellae more rounded than on the distal part of digits; eight precloacal pores in an angle series (Fig. 6b); enlarged postcloacal spurs – three (on the right side) and two (on the left side); dorsal surfaces of the

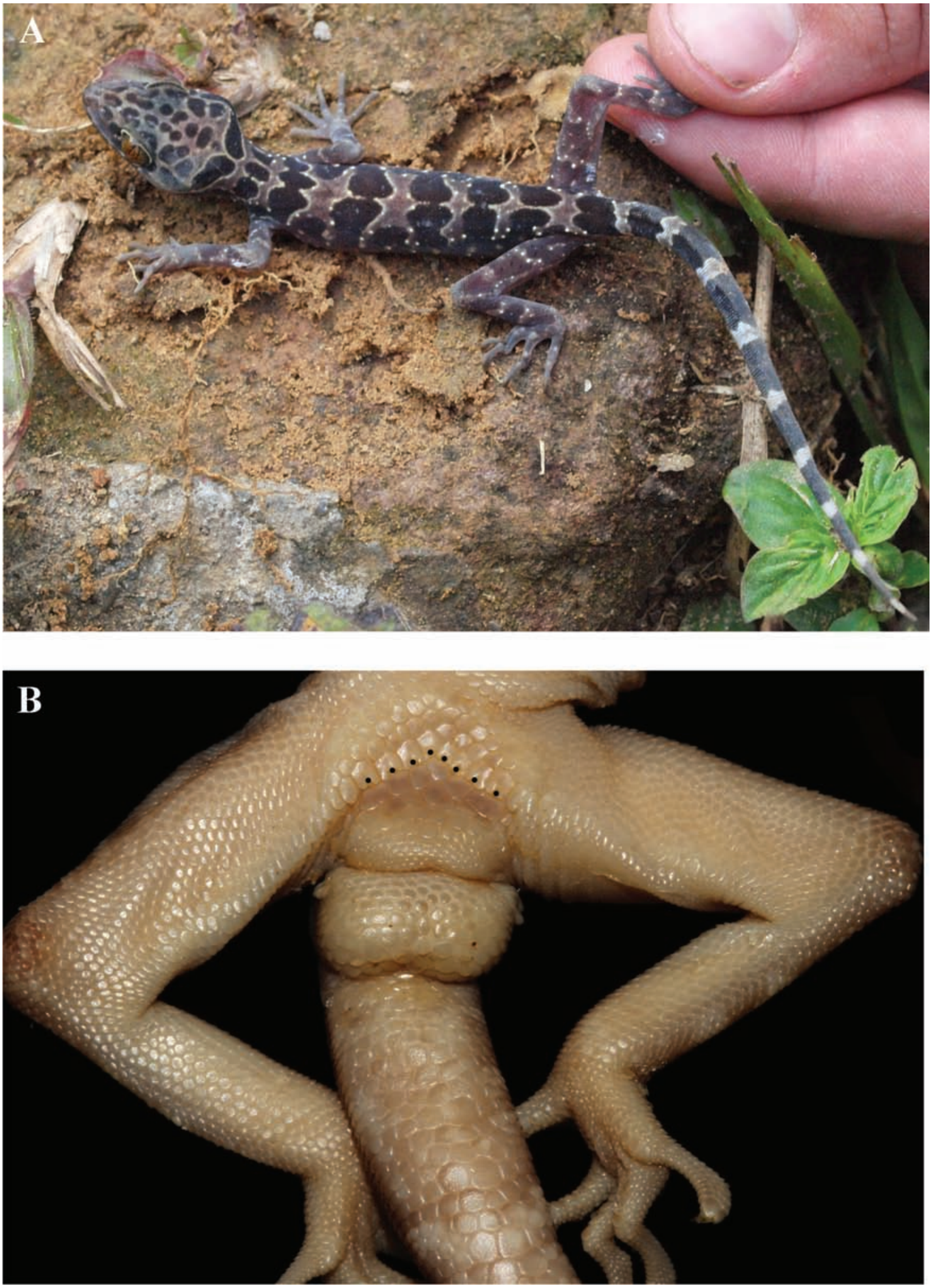


Fig. 6. *Cyrtodactylus spelaeus* sp. nov.: A – general view of type specimen; B – precloacal region with angular row of precloacal pores.

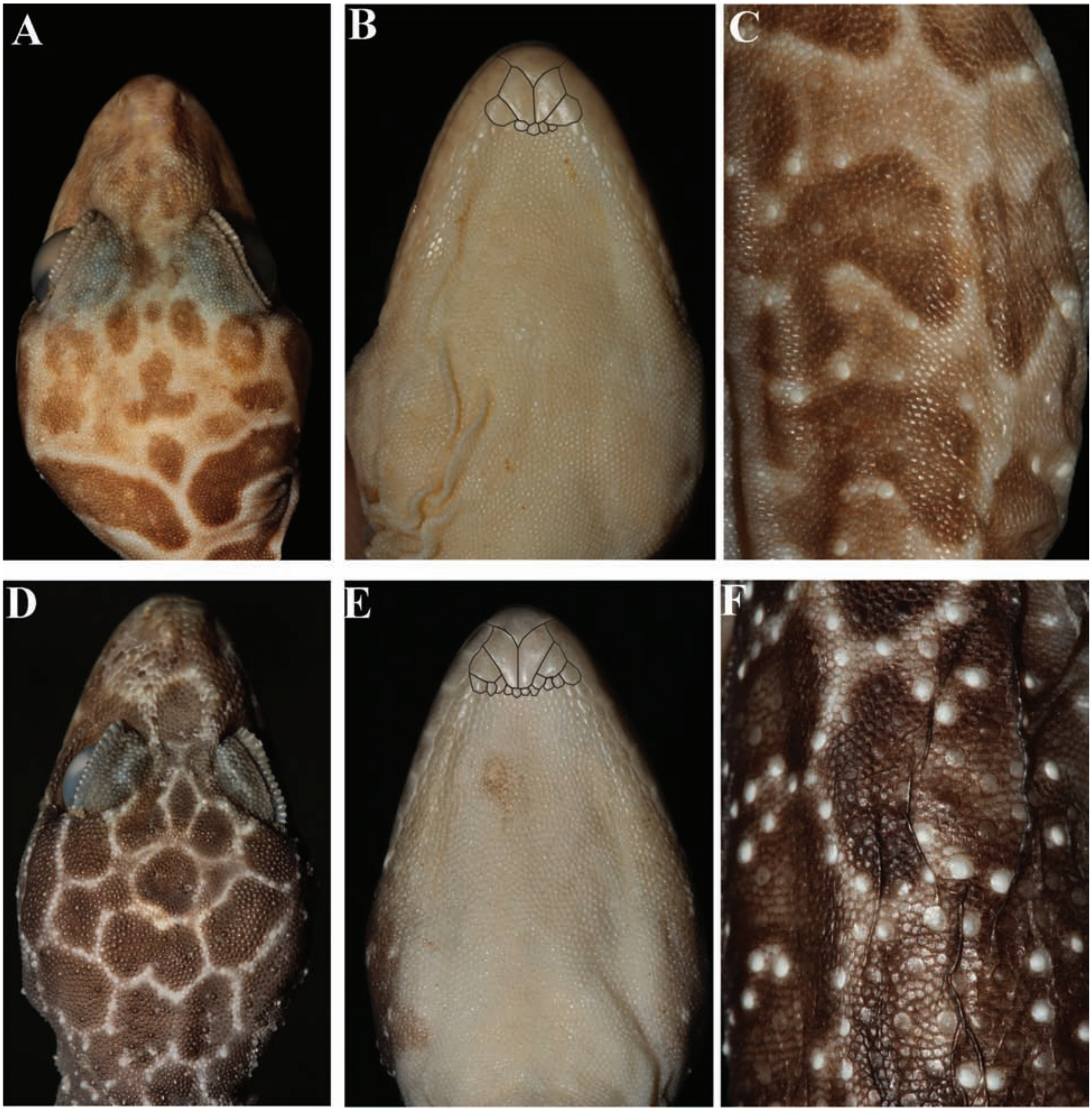


Fig. 7. Morphological comparison of *Cyrtodactylus spelaeus* sp. nov. (A–C) and *Cyrtodactylus wayakonei* (D–F): A – dorsal surface of the head; B – ventral surface of the head with mental scalation; C – dorsum surface with ten rows of enlarged tubercles; D – dorsal surface of the head with reticulated pattern; E – ventral surface of the head with mental scalation; F – dorsum surface with higher number rows of enlarged tubercles.

tail without enlarged keeled tubercles; posterior part of regenerated tail covered by flattened and rounded scales; subcaudals forming enlarged median row.

Coloration: Dorsal head surface light grey with few irregular dark brown butterfly–shaped blotches; nuchal band dark brown with light contrast margin, consists of two separate parts which contact posteriorly, extending from the neck to the posterior corners of eyes; labials light brown. Dorsum light with seven irregular, dark brown transverse blotches with light

Table 6. Measurements and selected morphological characters of the type series of *Cyrtodactylus spelaeus* sp. nov.; f = female, m= male, sub = subadult.

	Holotype	Paratypes	
	ZMMU R – 14399	ZMMU R – 14400	ZIN 28258
Sex	m	f	m, sub.
SVL	88.9	91	61.8
TailL	80.1*	83*	69.3
Head L	26.3	26.4	19.6
Head W	16.9	18	12.1
Head H	10.8	10.4	7.5
SnEye	10.2	10.4	7.6
OrbD	5.6	6.1	4.6
EarL	2.3	2.3	1.5
EyeEar	8	7.6	5.5
TrunkL	30.8	42.8	23.8
LS	17.3	17	12.1
ForeaL	15.3	15.7	10.8
FemurL	20	21.4	15.1
Crus L	16.6	18.8	12.8
LD4A	9.1	10	6.8
LD4P	12.3	11.5	9
V	39	36	37
SLB	156	178	183
LF 4	19	20	19
LT 4	24	22	23
PP	8	0	9
SL	12	9	11
IL	10	8	9
TubL	24	28	32
TubW	10	10	10
SLH	90	92	89
SAH	84	82	81

margins, a median longitudinal light stripe runs along the vertebral column flanked by dark blotches. Flanks grayish white. Venter white, the lower side of toes and fingers light; dorsal surface of limbs and digits light gray with brown transverse bands. Tail basis with three dark brown bands which are wider than the light interspaces in-between, bands absent on regenerated part of the tail. Ventral surface of tail light. For coloration in life see Fig. 6a.

Variation of paratypes. For the variation of the type series see Table 6. Sexual dimorphism is well developed, precloacal and femoral pores are present in males only and males have better developed postcloacal spurs.

Comparisons with Laotian congeners. The new species *Cyrtodactylus spelaeus* sp. nov. differs from *C. buchardi* by having the singe median row of subcaudals and enlarged femoral scales (both lacking in *C. buchardi*), fewer dorsal tubercle rows (10 vs. 25), more ventral scales (37–39 vs. 30), and greater number of subdigital lamellae under the fourth finger and toe (19–20 and 22–24 vs. 14 and 12, respectively).

The new species can be distinguished from *C. interdigitalis* by having transversal enlarged subcaudal



Fig. 8. Habitat of *Cyrtodactylus darevskii* sp. nov. and *Cyrtodactylus khammouanensis* sp. nov. nearly Na Phao Village, Boulapha District, Khammouane Province, Laos.

scales (absent in *C. interdigitalis*); lesser number of precloacal and femoral pores in the singe row (8–9 vs. 32 in *C. interdigitalis*); roundish tail *versus* flattened tail; blotched dorsal pattern in the new species *versus* 4–5 wide brownish jagged transversal bands; no webbing between toes *versus* developed web on toe basis in *C. interdigitalis*. *Cyrtodactylus spelaeus* **sp. nov.** can be diagnosed from *C. jaegeri* by the larger body size (maximum SVL 91 mm vs. 68.5 mm), a higher number of ventral scales (37–39 vs. 31–32) and dorsal color pattern (dark irregular butterfly-shaped blotches vs. wide transversal dark bands in *C. jaegeri*). The new species differs from *C. jarujini* by having lesser number of pores (8–9 vs. 52–54 in *C. jarujini*), more ventral scales (37–39 vs. 30–38), and greater number of subdigital lamellae (LF4 19–20 and LT4 23–24 vs. 12–17 and 11–18 respectively). The new species is distinguishable from *C. lomyenensis* by its larger body size (maximum SVL 91 mm vs. 72.1 mm in *C. lomyenensis*), a higher number of ventral scales (37–39 vs. 35–36), and dorsal coloration pattern (butterfly-shaped blotches vs. wide bands in *C. lomyenensis*). *Cyrtodactylus spelaeus* sp. nov. differs from *C. pageli* by the following morphological characters: dorsal color pattern (blotches vs. transversal dark bands in *C. pageli*), greater number of precloacal pores (8–9 vs. 4–6 in *C. pageli*), somewhat fewer rows of enlarged dorsal tubercles (10 vs. 9–14 in *C. pageli*). From *C. roesleri* the new species is distinguishable by having a lesser number of pores (8–9 vs. 20–28), larger maximum body size (91 mm vs. 75.3 mm) and by dorsal pattern (irregular, dark blotches vs. wide transverse dark bands in *C. roesleri*). The new species differs from *C. teyniei* in absence of pores in females *versus* 13 or 14 pores known for *C. teyniei*, as well as in dorsal coloration pattern (dark irregular butterfly-shaped blotches vs. dark brown oblong blotches in *C. teyniei*) and presence of a nuchal loop (vs. nuchal loop absent in *C. teyniei*).



Fig. 9. Habitat of *Cyrtodactylus multiporus* sp. nov. in environs of Na Home Village, Boulapha District, Khammouane Province, Laos.

The new species is distinguishable from *C. puhuensis* by a higher number of precloacal pores (8–9 vs. 5 precloacal pores in *C. puhuensis*), and by a different dorsal coloration pattern (dark irregular blotches vs. light narrow bands in *C. puhuensis*). The new species differs from *C. vilaphongi* in having enlarged median row of subcaudals, higher number of ventral scales (37–39 vs. 34–36) and different dorsal coloration pattern (irregular, dark blotches vs. narrow yellowish white bands in *C. vilaphongi*).

The new species is morphologically quite similar with *C. wayakonei*, sharing many diagnostic features, such as the number of precloacal pores 8–9 in the new species *versus* 6–8 in *C. wayakonei*, quite similar dorsal color pattern, lacking of femoral pores and similar state of subcaudal scalation in both species. But the new species is greately different from *C. wayakonei* in COI gene sequences (p = 16.7%) and can be further diagnosed from this species by having a fewer number of longitudinal rows of enlarged dorsal tubercles (10 vs. 17–19 in *C. wayakonei*) (Fig. 7c,f), somewhat higher number of subdigital lamellae (LF4 19–20 and LT4 22–24 vs. 17–18 and 19–20 respectively), by presence of distinct nuchal band *versus* not developed nuchal band in *C. wayakonei*, and by dorsal surface of head having few dark roundish spots *versus* reticulated grey-brown patterns in *C. wayakonei* (Fig. 7a, d).

Etymology. The species epithet “spelaeus” is a Latin adjective in masculine, derived from the Latin “spelaeum”, “spelaean”, “living in a cave” referring to the habitat and the type locality of the new species – the Khuang Lang Cave in Kasi District of the Vientiane Province of Laos.

Habitat description. The new species inhabits typical limestone karst area covered with lush vegetation. All specimens were found on the wall inside the karst cave.

Distribution. To date the new species has been reported only from the environs of its type locality

in Khuang Lang Cave National Park, Kasi, Vientiane Province, Laos.

Phylogenetic position. A member of *C. wayakonei* species group; most closely related to a clade joining *C. vilaphongi* from Luang Prabang Province of Laos and *C. puhuensis* from Houphan Province of northern Laos and Thanh Hoa Province of northern Vietnam; uncorrected genetic distance between these taxa and the new species comprise $p = 11.48–12.30\%$.

DISCUSSION

Taxonomic diversity of South-East Asian bent-toed geckoes is astonishing and in many areas still remains unexplored. In Vietnam, the number of described species of the genus *Cyrtodactylus* has increased rapidly since 2007, growing from 5 species known in 2006 to 33 species recognized in 2014 (Nguyen et al. 2014). However diversity of *Cyrtodactylus* in such areas of Indochina as Laos and Cambodia is comparatively poorly studied (Schneider et al. 2014b). The recent and rapidly increasing number of described species indicates the need for further exploration. DNA barcoding (using fragment sequences of COI, cytochrome c oxidase subunit I) allows the estimation of biodiversity and species identity, and serves an efficient tool may point to populations in need of further investigation and was successfully applied to many groups of reptiles, including the genus *Cyrtodactylus* (Nazarov et al. 2012; Nagy et al. 2012; Murphy et al. 2013; Nguyen et al. 2013, 2014; Schneider et al. 2014a, 2014b).

Herein we successfully applied COI DNA barcoding for scrutinizing diversity of Laotian *Cyrtodactylus*. This work includes 11 of 15 recognized species (73.3%) of *Cyrtodactylus* in Laos, including our four new species. At least one additional undescribed taxon occurs in Luang Prabang Province of Laos (Schneider et al. 2014b). DNA barcoding using COI efficiently guided species delimitation and discovery of new lineages (Nazarov et al. 2012; Nguyen et al. 2014). Further application of molecular methods including COI DNA barcoding is required for proper assessment of *Cyrtodactylus* taxonomic diversity.

Application of molecular methods is also important for re-evaluation of morpohological characters used in *Cyrtodactylus* taxonomy. Such important features of external morphology as subcaudal scalation, number and position of precloacal and femoral pores agree well with grouping of taxa proposed by the results of COI barcoding. Thus, the tree species of *Cyrtodactylus* described from Phong Nha – Ke Bang National Park in Quang Binh Province of Vietnam (*C. phonghnakebangensis*, *C. roesleri* and *C. cryptus*) are superficially quite similar to each other and have similar dorsal patterns. However, *C. cryptus* (showing absence of enlarged subcaudals and femoral pores; features characteristic to the members of *C. irregularis* species complex), based on the phylogenetic hypothesis derived from COI sequence data and in full agreement with morphology, is clearly grouped with other members of *C. irregularis* species complex.

Morphologically, *Cyrtodactylus darevskii* sp. nov. is most similar to *C. teyniei* from Khammouane Province, especially in its dorsal pattern. Both species are limestone-dwelling bent-toed geckos and the distance between the type localities of these species is approximately 100 km. Nonetheless, *C. darevskii* sp. nov. is distantly related to *C. teyniei* based on the molecular data, which suggests that similarity in dorsal pattern and other morphological features might be caused by morphological convergence evolution. Our analysis indicate that *C. darevskii* sp. nov. is closely related to *C. phongnhakebangensis*, whereas *C. teyniei* is genetically quite close to morphologically distant *C. multiporus* sp. nov. It is noteworthy that both *C. darevskii* sp. nov. and *C. phongnhakebangensis* show well-pronounced comlete nuchal loop, whereas both *C. teyniei* and *C. multiporus* lack nuchal loop.

Three of the four new *Cyrtodactylus* species described herein (*C. darevskii* sp. nov., *C. khammouaensis* sp. nov. and *C. multiporus* sp. nov.) were found in the same locality in the environs of the Na Home Village, Khammouane Province; two of them (*C. darevskii* **sp. nov.**, *C. khammouaensis* sp. nov.) occurred in the same biotope. This example illustrates the amazing diversity of the genus *Cyrtodactylus* even in a very limited area; it is undoubtful that number of recognized *Cyrtodactylus* species will only continue to grow in future.

According to our data, to date the following species of *Cyrtodactylus* are documented to occur in Laos: *C. buchardi*, *C. darevskii* sp. nov., *C. interdigitalis*, *C. spelaeus* sp. nov., *C. jaegeri*, *C. jarujini*, *C. khammouanensis* sp. nov., *C. lomyenensis*, *C. multiporus* sp. nov., *C. pageli*, *C. puhuensis*, *C. roesleri*, *C. teyniei*, *C. vilaphongi*, *C. wayakonei*.

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